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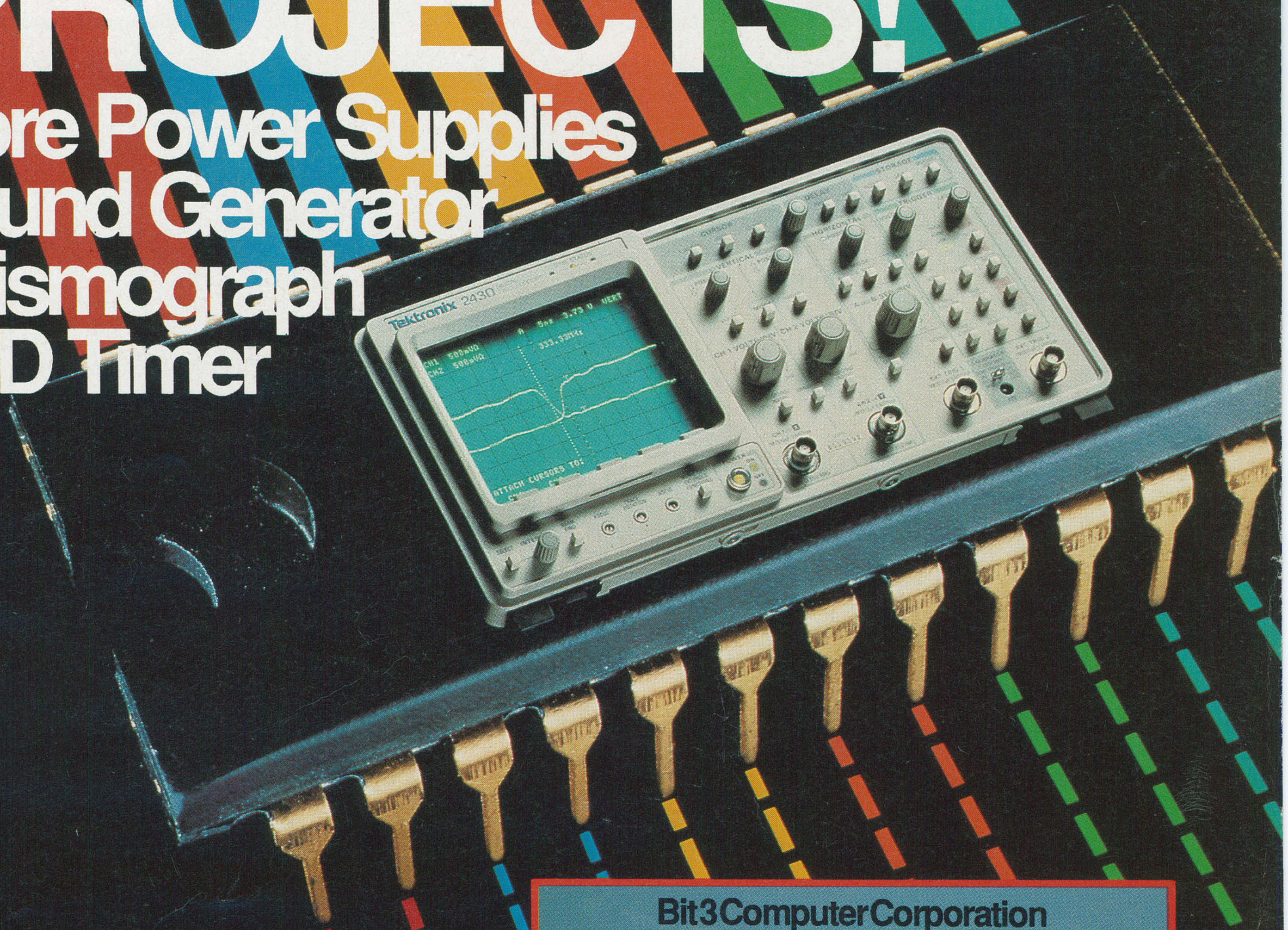

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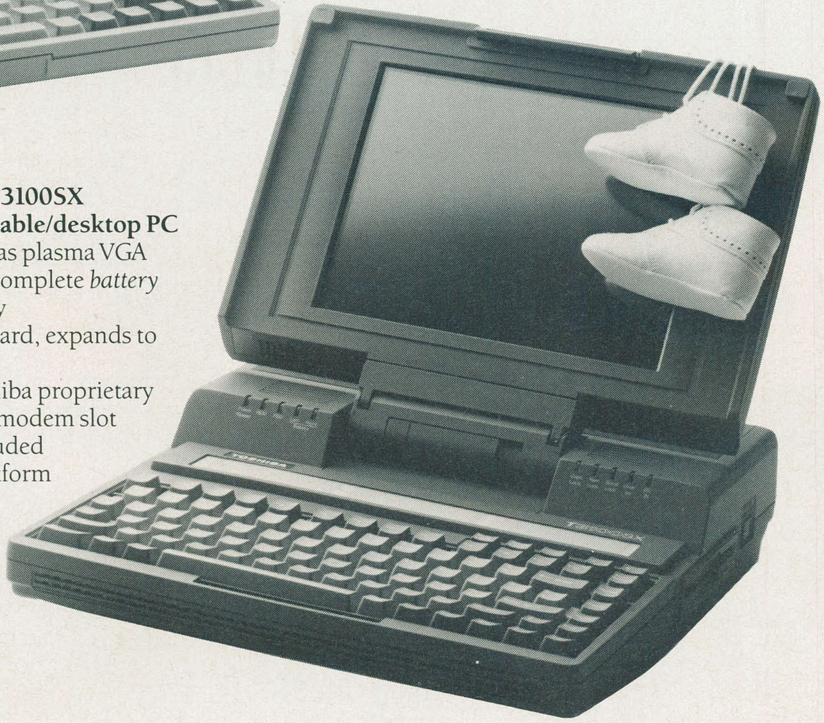

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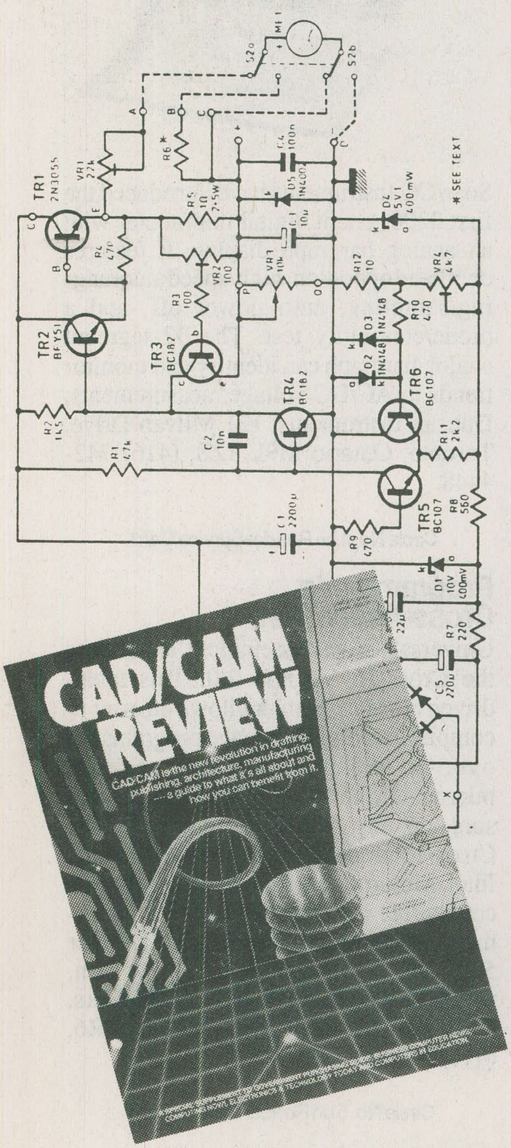

FEATURES

PROJECTS

INFORMATION

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We do not supply printed circuits or kits, and we do not keep track of availability. However, PCBs for projects are available from the following mail order sources:

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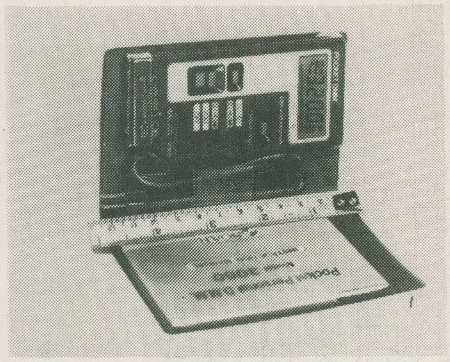
DMM With Bargraph



Soar/CG Instruments have introduced the first 3200- count digital multimeter with an analog bargraph display. It features one-hand operation, high-speed autoranging/sampling, auto power off, and a diode/continuity test. The 32-segment analog bargraph can identify and monitor trends in AC/DC voltage measurements. Duncan Instruments, 121 Milvan Drive, Toronto, Ontario M9L 1Z8, (416) 742-4448.

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Programmer's Cross-Assembler
Universal Cross-Assemblers announces the Cross-16 Version 2.0. This table-driven cross-assembler allows the user to compile assembly language programs for over 20 different microprocessors, microcontrollers and digital signal processors, on any MS-DOS computer. The Cross-16 produces hex output files in the Intel, Motorola and binary formats, so it's compatible with most EPROM programmers and emulators. It's available in either 5.25" or 3.5" formats for $119 Cdn, postpaid. Universal Cross- Assemblers, PO Box 6158, Saint John, NB E2L 4R6, (416) 506-847-0681.

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A series of high-performance permanent-magnet stepping motors is described in a new brochure from Canon USA Inc. The compact units offer high torque-to-size ratios and step angles of 7.5 or 15 degrees. Holding torque ranges are 240-2250 g-cm; rated voltages are 12 or 24VDC. Canon USA Inc., Components Div., One Canon Plaza, Lake Success, NY 11042, (516) 488-6700, Fax (516) 354-1114.

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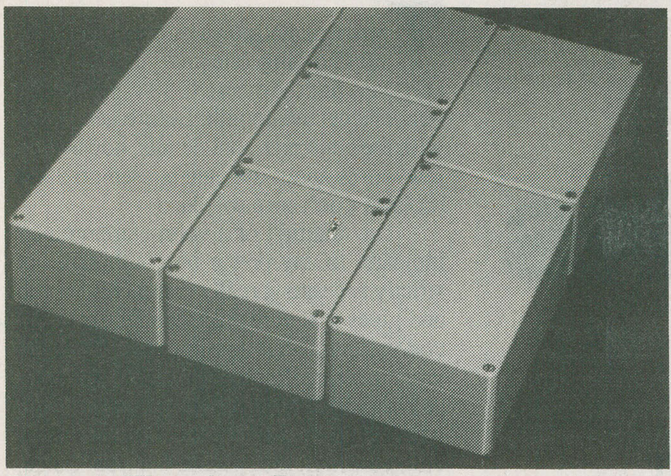

Diecast, Fibreglass Boxes

Hammond Manufacturing announces the introduction of the new Rolec series of aluminum diecast and fibreglass enclosures. Eight sizes of fibreglass and 52 sizes of aluminum enclosures are available, with stainless steel hardware and other optional accessories. Hammond Manufacturing Company Limited, 394 Edinburgh Road N., Guelph, Ontario N1H 1E5, Toronto (416) 456-3770, Guelph (519) 822-2960, Fax (519) 822-0715.

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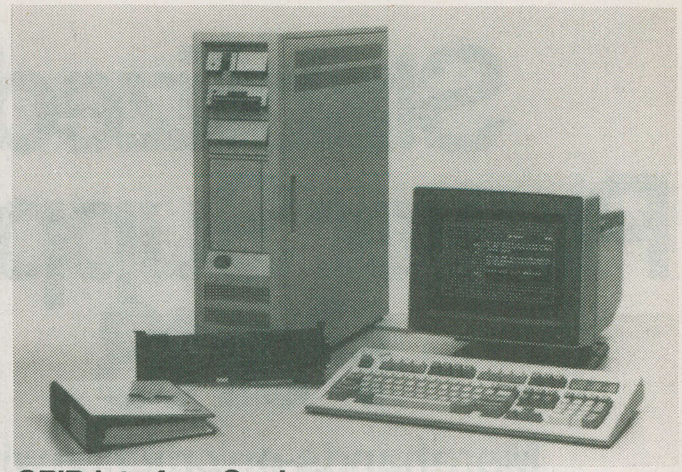

GPIB Interface Card

The new Philips PM 2202 GPIB Interface card from Fluke Electronics turns an IBM PS/2 computer into a versatile controller for GPIB/IEEE-488 instrumentation and measurement systems (the 2201 is for the PC/XT/AT series). The included software includes all commonly used functions; no hardware setup is required. Fluke Electronics Canada Inc., 400 Britannia Rd. E., Unit #1, Mississauga, Ontario L4Z 1X9, (416) 890-7600, Fax 890-6866.

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Training Software

BNH Expert Engineering Software announces Axess training aid software for IBM compatibles. It can be used to design and present the course, test and grade trainees, simulate various operations, and manage the administrative aspects of the course. BNH Expert Engineering Software Inc., 7575 Trans Canada Highway, Suite 103, Saint Laurent, Quebec H4T 1V6, (514) 745-4010.

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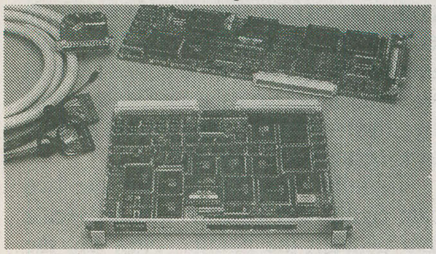

The second photo on our cover is the Bit 3 Model 456 adapter, which allows the Apple NuBus and the VME industrial computer standard to talk to each other. If you'd like more information, you can fill out the Reader Service Card, or contact Bit 3 Computer Corporation, 8120 Penn Avenue South, Minneapolis, Minnesota 55431-1393, (612) 881-6955, Fax (612) 881-9674.

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FEATURE

Stabilized Power Supplies Part3

More hands-on practice with two regulated power supplies.

STEVE KNIGHT

Two regulated power supplies with current limiting, one providing 0 to 25V at 700mA and the other 0 to 30V at 1.0A, are our subjects this month. Before getting on with the constructional details, however, a few words about the meters used on these projects won't be out of place.

The addition of a voltmeter/ammeter indicator to any power unit, although not strictly necessary, really completes the job and gives it a more professional finish. Of course, it is always possible to calibrate the voltage control knob on the panel with voltage markers, and since for a stabilized supply there is negligible variation in the output voltage within the specified current range, this is an inexpensive alternative. If cost is also in mind, a single voltmeter can be fitted; this will indicate gross current overloads by either falling to zero on short-circuited loads or failing to increase when the normal current has been exceeded.

The thing to try to avoid is rescaling a meter which has a scale marked in a completely different fashion from what is actually wanted. This *can* be done and the author has rescaled many, but it is a job that requires some skill and a whole lot of patience in removing an existing scale without damaging the instrument itself and some reasonable artistry in marking the new scale to its proper divisions.

Meter

In both this month's designs, a 50uA meter, has been used. This is a large meter measuring 110mm X 83mm and the scale, as provided, is marked (naturally) 0-50uA.

The scale changes needed are fairly simple to carry out, but don't under any circumstances do this on a dirty bench top or anywhere else where there are iron fillings or other pieces of eager minutiae waiting to get into the moving-coil mechanism and jam everything solid. Find yourself a dust free corner away from the wife, kids and the dog; then carefully remove the plastic covering and put it to one side.

Equally carefully remove the two scale fixing screws and *slide* the scale from beneath the pointer. Now put the meter and the two screws inside the plastic cover and put the lot in a safe place.

Meter Scale

The first of this month's project's needs a scale reading 0-25V and 0-1A, and Fig. 1a and Fig. 1b show the scale before modification and afterwards. You need instant lettering with figures that reasonably match those already in the scale.

The existing uA marking and scale

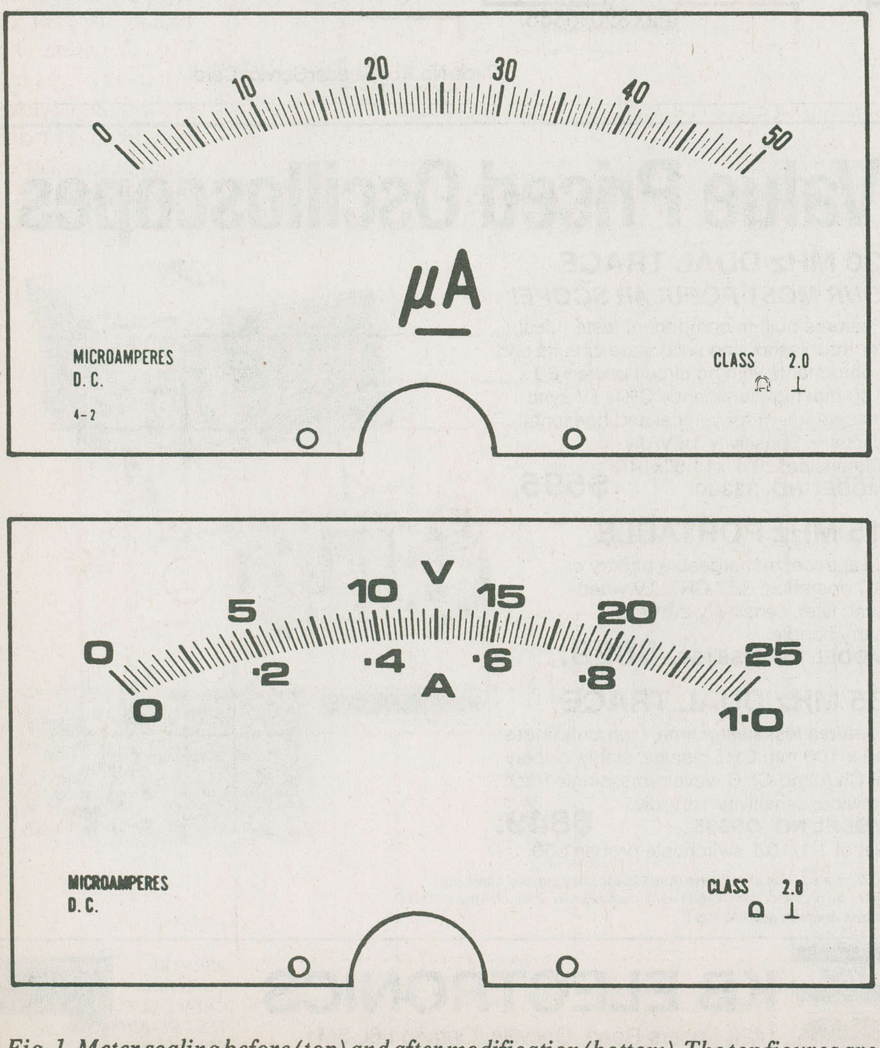


Fig. 1. Meter scaling before (top) and after modification (bottom). The top figures are removed, as well as the uA marking.

figures have now to be removed; this is best done by *gently* scraping them with a used razor blade, keeping the blade at right angles to the surface and avoiding "digging in" the corner of the blade. This sounds as though we are going to end up with a patchy surface but with the necessary patience the scale print will come off and leave the underlying white surface undisturbed.

Practise on the small unimportant printing at the foot of the scale first. Then get rid of all the dust and add the V and A lettering and the additional numbering as shown in Fig. 1b. You then have a scale reading 0-25V and 0-1A.

For the second project we need a scale reading 0-30V and 0-1A. Here the voltage scale doesn't fit readily into the existing divisions, so we leave the 0-50 markings as they are and add only the current figures 0-1A in exactly the same way as before. True, we shall only be using three-fifths of the scale length for our 30V output, but these scales are quite large and easily read so this is no great hardship.

Reassemble the scale on to the meter, taking care that the screws don't fall into the works, and snap the cover back into place. Do this at the bottom first so that the zeroing button engages properly. It should do this without adjustment if you haven't disturbed it.

You can if you wish use a smaller 50uA version of this meter, the type T21, and modify the scale in the same way. If you don't fancy rescaling meters in this way, use separate meters for voltage and current. The 1A type T30 and the 30V type T43 are suitable.

Regulated Supplies

Both projects to be described are very similar in construction and apart from a few minor details, the assembly instructions which follow can apply equally to both designs. Both circuits use discrete transistors, four in the case of the 25V unit and six in the case of the 30V unit.

Some might think that the circuits are retrograde in that they are not using integrated packages, but apart from fairly expensive regulator ICs, the performance figures for these designs are better than those obtainable from integrated systems. Also, few external components are saved by their use and additional circuitry is nearly always required to get the output voltage range from IC regulators down to zero.

Both circuits operate on the principles shown in the block diagram of Fig. 2 where the various parts covered in previous issues are now brought together in practical form.

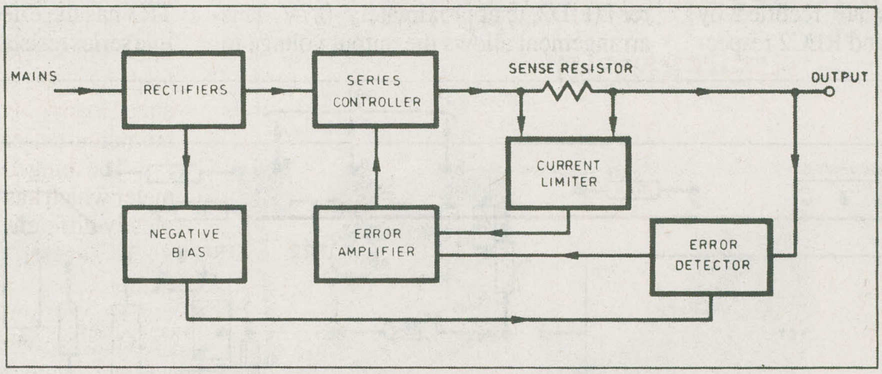


Fig. 2. The general block diagram for the two stabilized supplies.

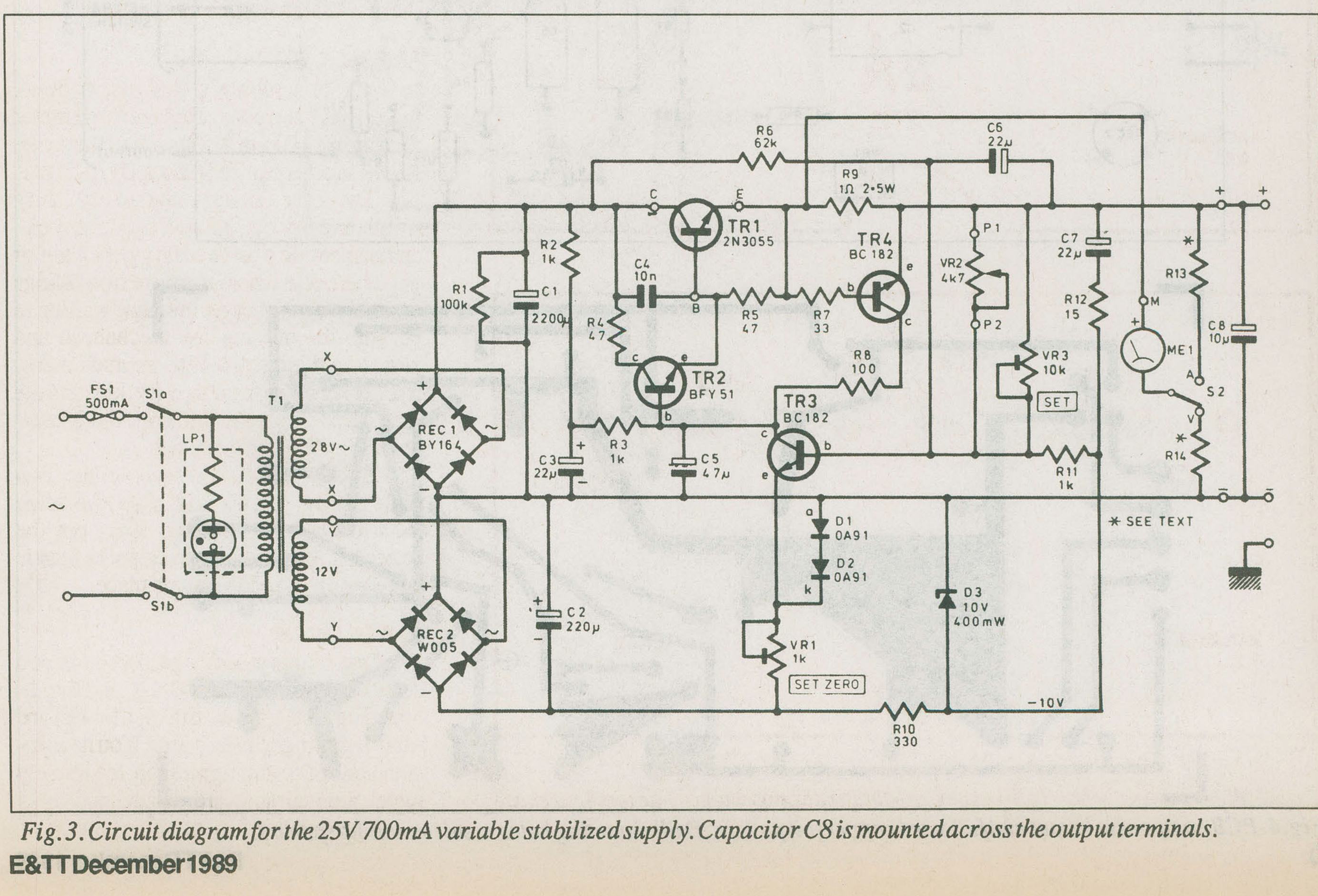


Fig. 3. Circuit diagram for the 25V 700mA variable stabilized supply. Capacitor C8 is mounted across the output terminals.

VARIABLE STABILIZED POWER SUPPLY

0-25V at 700mA maximum, ripple less than 3mV RMS

The circuit diagram for the 0-25V Stabilized Power Supply is shown in Fig. 3. This design will provide a highly stabilized output adjustable from 0 to 25V at a maximum current of 700mA and with a ripple of less than 3mV RMS at full load. The output impedance is one ohm, D.C. to 80kHz.

The power input is derived from transformer T1 which has two secondary windings, one of 28V at a current rating of 1.5A and the other of 12V at a rating of 100mA. Both of these supplies are rectified by bridge rectifiers REC1 and REC2 respectively. After smoothing by capacitor C1, the positive supply line from REC1 goes on through the series regulator transistor TR1, a 2N3055 (or a 2N3771 may be used), and the current sense resistor R9 to the positive supply output terminal.

The output from bridge rectifier REC2 provides, after smoothing by capacitor C2, a negative line which supplies the zener reference diode D3 and also biasses the emitter of the error detector D1, D2, to approximately -0.7V. This arrangement allows the output voltage to be taken down to zero.

The series regulator transistor Tr1 carries the whole of the output current and acts as an automatic resistance. Its base current is controlled by the error amplifier TR2 which amplifies the output from the error detector TR3 to a level sufficient to drive the base of TR1.

Base bias for TR1 and collector bias for Tr2 are provided by resistor R4. Hence, whatever happens at the base of TR3 has the effect of adjusting the effective series resistance of TR1.

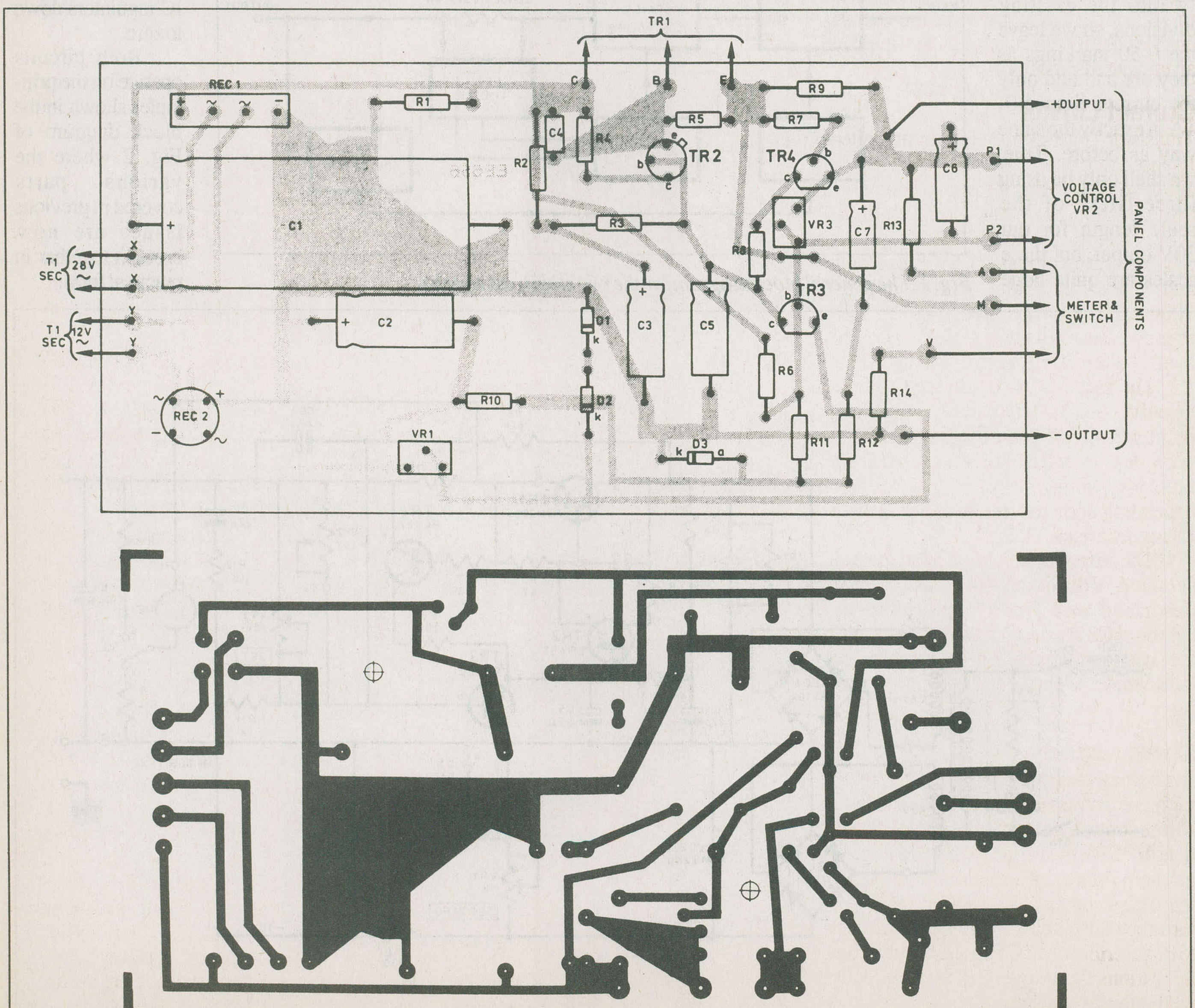


Fig. 4. PCB component layout and full sized copper foil pattern. Drill mounting holes to suit mounting spacers.

The base of TR3 connects to the voltage adjusting potentiometer VR2. The control sets the required output voltage to anything between 0V and 25V. Once this is set, any unwanted variation in the output level is passed to the base of TR3 and initiates the feedback to TR1.

Suppose the output tends to fall slightly. The voltage at the base of TR3 falls and its collector current (derived through resistors R2-R3) also falls. This increases the base current of TR1. This reduces the resistance of TR1 and the output fall is compensated.

This regulation also acts to reduce the output ripple voltage; any ripple on the rectifier side of transistor TR1 is passed by way of resistor R6 to the base of the error detector (TR3), and this, together with capacitor C6 effectively bypassing VR2 to AC ripple components in the output, enables the feedback to treat the ripple as an unwanted variation.

Current Limiter

Transistor Tr4 serves as the current limiter. Its base-emitter bias is derived from the voltage developed across the series resistor R9. Providing that this voltage is less than about 0.7V, TR4 remains switched off.

The value of resistor R9 is one ohm and when the output current reaches 700mA, the voltage drop is 0.7V. This then switches transistor TR4 on and takes control away from the error detector TR3.

The base of Tr2 consequently moves negative and TR1 is biased back to the point where a 700mA current cannot be exceeded. In actual practice, the current limit may lie between 650 and 750mA, depending upon the tolerances of resistor R9 and transistor TR3.

The output is monitored by the switch selected Voltmeter/Ammeter already described and finally smoothed by capacitor C8. Preset controls VR1 and VR3 are used to set up the voltage limit reading on the meter when the unit is ready for testing.

Construction

Everything except the mains transformer, the meter and its switching, and the voltage adjust control, goes on to a printed circuit board (PCB). In turn, this PCB screws on to a simple aluminum heatsink which carries the series regulator transistor TR1. The same heatsink is used in the second project to be described, and what is said here about the various mountings will apply equally well to the later design.

The circuit board component layout and full-size copper foil master pattern is shown in Fig. 4.

When assembling this board the only precautions to be taken are, the usual ones of getting the rectifiers, electrolytics and diodes the right way round. More care is needed for bridge rectifier REC2 than for REC1. Bridge REC1 can only go in one of two ways but REC2 can go in any one of four.

Check very carefully, and take care with the soldering, in particular around the transistor connections. Transistor TR2 must have a corrugated type heatsink pushed on to it, and wirewound resistor R9 should be spaced away from the surface of the board by at least 3mm. There is a short link needed immediately below the position of VR3, don't overlook this or the meter won't work, although everything else will.

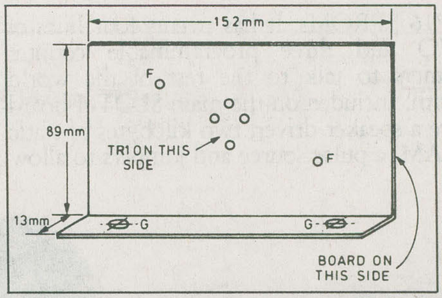


Fig. 5. Heatsink drilling details. Holes at F to match PCB; centre holes TO3 pattern.

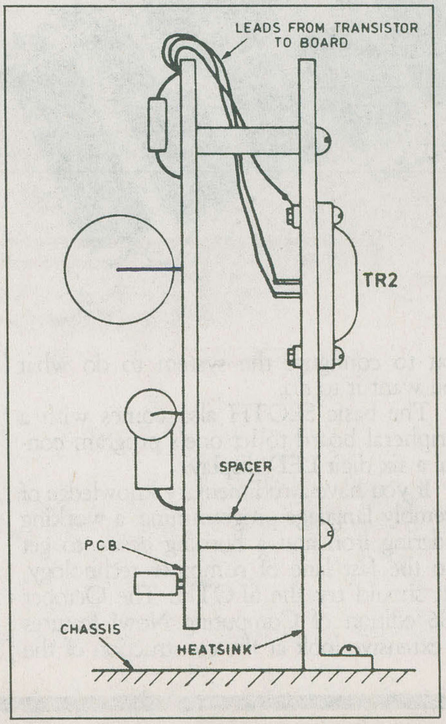


Fig. 6. Circuit board mounted on heatsink.

Ammeter/Voltmeter

Resistors R13 and R14 need a few words. These convert the basic 50uA meter movement into an ammeter (A) and a voltmeter (V) respectively. Resistor R14 is switched in series with the meter on the *voltage range*; since the meter has to read 25V full scale deflection (FSD) and its own internal resistance is stated to be 1700ohms, we have to

PARTS LIST 25V UNIT

Resistors

R1 .... 100k
R2,3 .... 1k0.5W
R4,5 47
R6 .... 62k
R7 33
R8 100
R9 .... 12.5W wirewound
R10 330
R11 .... 1K
R12 15
R13 .... 18K 1% (see text)
R14 .... 510k 1%

Potentiometers

VR1 .... 1k min. preset, vert.
VR2 .... 4k7 carbon, lin.
Vr3 .... 10k min. preset, vert.

Capacitors

C1 .... 2200u elec. 63V
C2 .... 220u elec. 25V
C3,C6,C7 .... 22u elec. 25V
C4 .... 10n metal film
C5 .... 47u elec. 25V
C8 .... 10u tantalum 35V

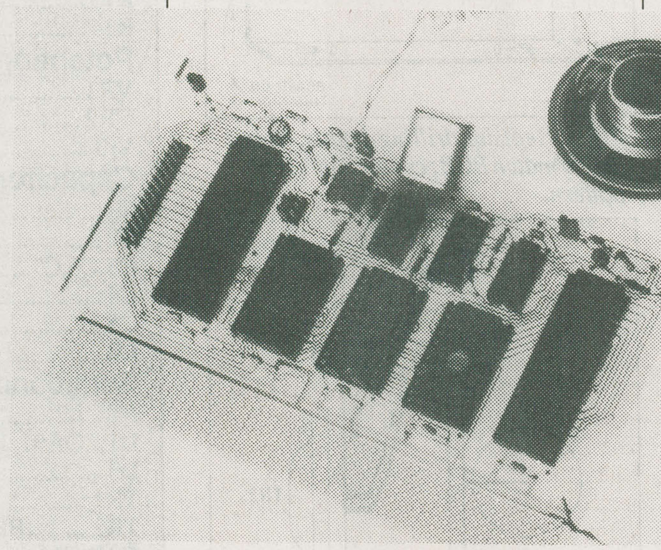
Semiconductors

REC1,2 .... 1.5A or larger bridge
D1,2 OA91, 1N34, 1N60 germanium
D3 .... 10V 400mW Zener
TR1 .... 2N3055 NPN power
TR2 .... BFY51, 2N2297, 2N2219
TR3,TR4 .... BC182, 2N3904

Miscellaneous

S1 .... 2-pole toggle (or slide)
S2 .... centre-off toggle
LP1 neon pilot with internal resistor
T1 28V 1A and 12V 100mA transformers
ME1 .... 50uA moving coil meter

Case, front panel minimum of 229X127mm; 16 gauge aluminum heatsinks corrugated TO heatsink; terminals, 4mm type 1 black, 1 red; 500mA fuse; connecting wire, solder, etc.



restrict the current through it to 50uA when 25V is applied to it and R14 in series. By Ohm's law we get: R14 = 25/(50 x 10^{-6}) = 500k ohms, less 1700 ohms = 498,300 ohms.

Well, we aren't going to pick that off the shelf, and the best we can do is to use a 510k ohm, 1 percent resistor. This will tend to make the reading slightly on the low side but this is compensated for by the fact that the voltage is actually being measured on the higher potential side of resistor R9 and what appears at the terminals is always slightly less than this.

For the *current reading*, the FSD is 1A. What we are now effectively reading is the voltage drop across R9 interpreted in terms of current. If 1A flowed through R9 it would drop 1V, hence we want the meter to provide FSD when 1V is applied to it and the series resistor R13. Hence R13 = 1/(50 X 10^{-6}) = 20k ohm, less 1700 ohm = 18.3k ohm. An 18k ohm, 1 percent resistor will do here.

If, of course, you use any alternative meter, you will need to recalculate these values.

Heatsink

We now have to fit the circuit board to the heatsink which carries the 2N3055 series controller transistor (TR1), and we do this in the same way as we did for last month's project. Bend a piece of 16 gauge aluminum (you can use 14 gauge if you want) to the dimensions shown in Fig 5.

Place the board on the heatsink, away from the "bend" side, and mark through the two mounting holes. The board will be screwed to the aluminum sink at these points using 1/2in. spacers or similar.

Let the bottom edge of the board be a quarter inch or so above the foot of the aluminum. There is nothing critical about the actual positioning.

Spray the heatsink black if possible and mount TR1 at its center, insulating the transistor TO3 case from direct contact with the aluminum with the usual insulating kit. A silicone rubber washer is preferable to mica here, but if you use the latter, give both sides of it a thin smear of heat transfer compound before mounting.

Solder three differently colored flexible leads to the emitter, base and collector (case) of transistor TR1 long enough to reach to the E, B and C solder pads at the top edge of the board after it has been screwed to the heatsink. It is easier if you have soldered Vero pins to these points, and the same, if you wish, to the other output pads.

When the board has been screwed to the heatsink, it should look something like Fig. 6; TR1 leads looping neatly over the top edge of the board and soldered to the appropriate pins. The spacers may be either metal or plastic types, 6BA or 4BA threaded. If you use metal types, ensure that they are not fouling the board wiring tracks. Their length is not critical, but 1/2in. should be considered a minimum.

This completes the board and heatsink assembly.

Boxing Up

We have not specified any particular case for this project (or for the next one come to that) because there is a vast range of suitable cases available at a vast range of prices. Enough to say that the front panel shouldn't measure less than about 229mm (9in.) wide by 127mm (5in.) high, and you will need a depth of 102mm (4in.) minimum.

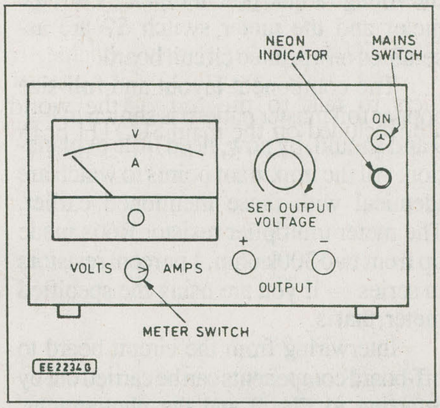


Fig. 7. Suggested front panel layout.

This panel size will allow room for the specified meter, the meter switch, the voltage adjust potentiometer, the mains switch and indicator neon and the output terminals. The mains lead can come in at the rear where the fuse can also be mounted. A suggested layout is shown in Fig. 7, with the lettering carried out in rub-down letters before the components are fitted.

Inside the box, mount the mains transformer and the heatsink and board panel. The wiring from the board to the external parts is fairly self-explanatory from the circuit diagram: there are two pairs of leads from the *XX*, *YY* points to the mains transformer T1 secondary windings (make sure you put them to the right windings) and three leads to the meter switch from points *A*, *M* and *V*.

There are two leads, positive and negative respectively, to the output terminals (note that capacitor C8 is soldered directly across these), and two leads from points P1, P2 to the voltage adjust potentiometer VR2.

Just one point about this last component; the *maximum* output voltage corresponds to the control resistance being all in, i.e. connect P1 to the slider or wiper (W) terminal and P2 to the terminal representing the fully *anticlockwise* position of the slider as viewed from the front. If you do get it wrong, no harm will be done, the output will just decrease instead of increasing as you advance the control clockwise.

Testing

Before switching on and testing the unit, carry out the following adjustments: set preset control VR3 fully anticlockwise i.e. all in circuit. Also preset VR1 to mid-position and the voltage adjust control VR2 fully anticlockwise (minimum output).

Put the meter switch S2 into the VOLTAGE (V) position. Switch on and carefully advance the voltage control on the front panel; if all is well, the voltmeter should read an increasing output.

If this does not happen, it may be that the meter switch has been wired the wrong way round, so switch over to the "amps" side as a quick check. If the meter now reads, reverse the switch wiring.

As the maximum of 25V is approached, adjust the voltage control VR2 *in conjunctions* with preset VR3 so that, by the time the voltage control has reached its maximum position, the voltmeter just reads 25V FSD (full scale deflection). Preset Vr3 is simply in parallel with VR2 and adjusts the total resistance to give the output level we want.

Now reduce the voltage control to its minimum setting and adjust preset VR1 so that the meter reads exactly zero. Return to maximum voltage and readjust VR3 if necessary to restore the output to 25V. This completes the voltage setting up.

To check on the current side of things and to ensure that the current limiter is working, switch over to CURRENT (A) on the meter switch S2 and short circuit the output. The ammeter should read somewhere about 700mA (0.7A).

This checks the limiting and also the current metering. Remove the short circuit and if by now nothing has started to complain, the power unit is ready for use.

Keep in mind when using this power unit, that once the current limit is reached, the voltage output will stay put and cannot be further increased. For example, suppose you have a load resistance of 30 ohms, then the greatest voltage you can get before 0.7A is reached is 21V. The voltmeter will not, therefore, go past the 21V position.

VARIABLE STABILIZED POWER SUPPLY

0-30V at 1A maximum.

The second of this month's offerings, a 0-30V regulated supply which will provide us with a maximum current of 1A. The complete circuit diagram for the 0-30V Stabilized Power Supply is shown in Fig. 8.

In most respects this circuit is similar to the one we have already discussed, as a glance at Fig. 8 will show. A mains transformer T1 with twin secondary windings provides a positive and a negative supply by way of the two bridge rectifiers and appropriate smoothing and there is the familiar series controller transistor TR1 with its driver TR2.

The error detector this time consists of a "long tailed pair", transistors TR5 and TR6 in a differential circuit. This gives an advantage over the previous supply in that stabilization against temperature changes is provided by this form of circuit. Only the difference between the two bases is amplified and temperature variations will tend to move both bases in the same direction.

The output from the collector of TR5 goes to the error amplifier TR4 which in turn drives the base of TR2. This, along with series controller TR1, forms a Darlington pair which controls the effective resistance of TR1 and so regulates the output against unwanted variations in the manner already described.

The current limiter this time is TR3 which senses the voltage developed across resistor R5, a part of which is tapped off by way of preset VR2. In this way the maximum output current can be set to 1A, or anything smaller if you so desire. The output is smoothed by capacitor C3 and protected against reverse input transients by diode D5.

Construction

The 0-30V unit is built in exactly the same way as the previous project. All components except the mains transformer T1, the voltage adjust potentiometer VR3, the meter and the meter switch S2 are assembled on a printed circuit board.

The component layout and full-size copper foil master pattern is shown in Fig. 9 and should, by now, need little explanation. All the important points to watch are identical with those mentioned earlier. The meter multiplier resistor R6 is made up from two 300k ohm, 1 percent resistors in series — if you are using the specified meter, that is.

Interwiring from the circuit board to off-board components can be carried out by referring to Fig. 9 and the photographs. Two pairs of leads from the points *Z-Z* and *X-X* go to the mains transformer secondary windings of 32V and 15V respectively.

Four leads from points *A, B, C* and *D* on the board go to the meter switch S2, which this time is a double-pole changeover miniature toggle (or you may use a slide type if you wish); two leads are taken to the voltage adjust potentiometer VR3, one of which is common to the output positive lead; and the positive and negative outputs themselves. Use at least 16/0.2mm flexible wire for the transformer connections and the output leads.

After completing the board and drilling the two fixing holes marked *F*, mark these through on to the heatsink, and drill these and the TO3 case fitting holes for TR1 in the same way as was described previously. Transistor TR1 should now be fitted to the heatsink, and the board screwed in place, using 1/2in. spacers; refer back to Fig. 6. Three colored leads from points *C, B* and *E* should be soldered to TR1 pins.

The assembly, together with the various other components can then be fitted into a suitable case and the panel layout can again follow that suggested in Fig. 7. The meter this time, of course, is calibrated 0-50V, 0-1A (see "Meter Scale" section).

Testing

Set preset VR1 and rotary control VR3 fully anticlockwise (all in, presets VR2 and VR4

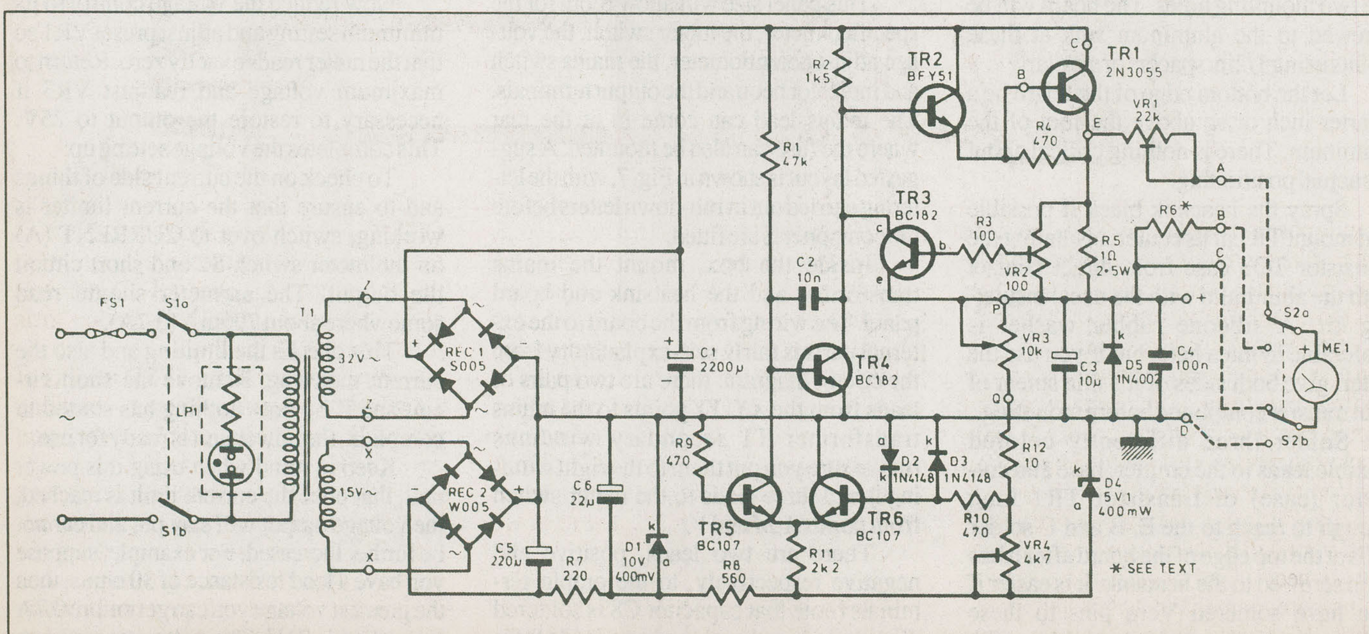
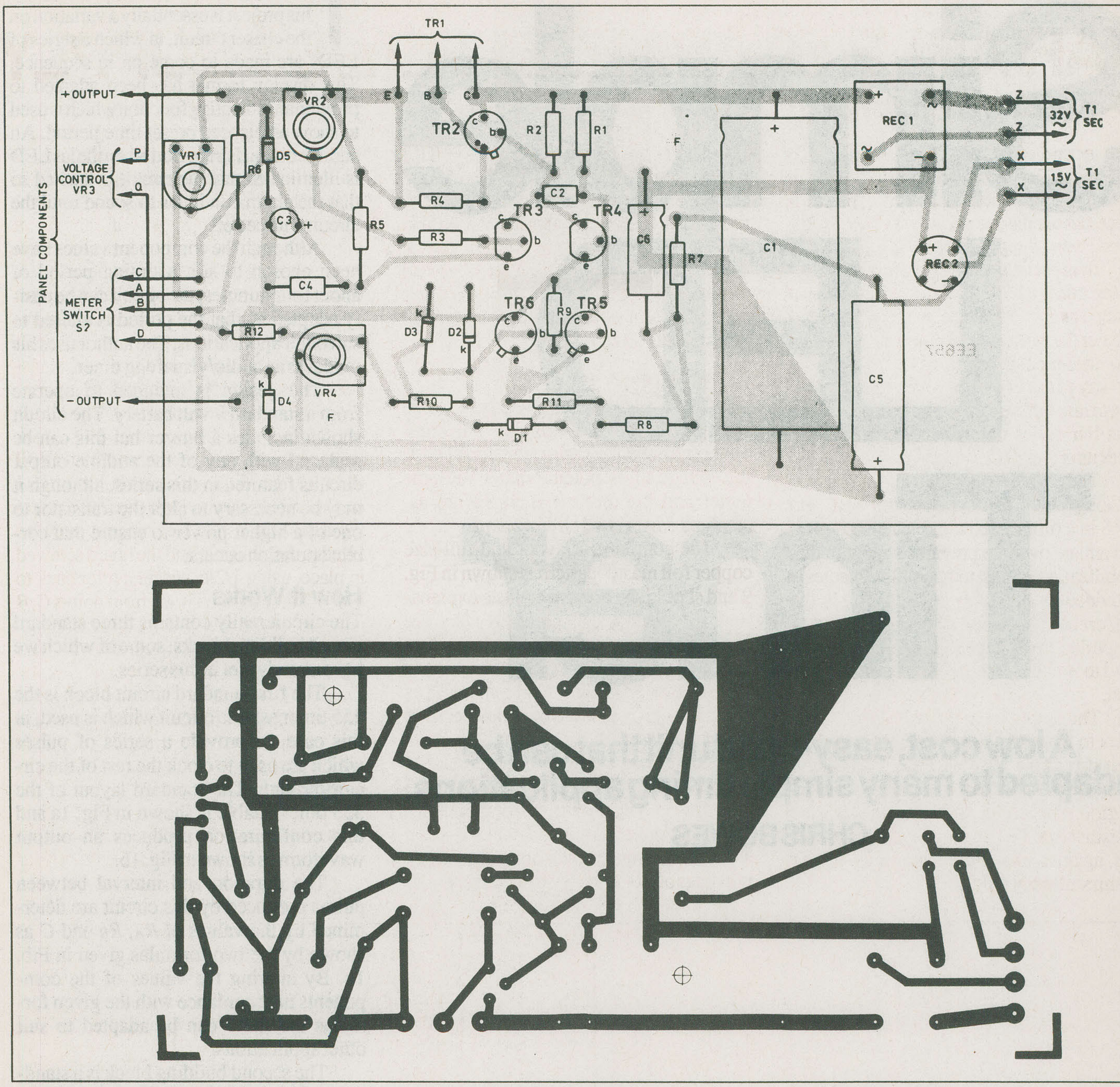


Fig. 8. Circuit diagram for the 0-30V 1A supply.



to mid-position. Note that VR3, the front panel voltage control, is wired so that all the track resistance is in circuit with the wiper fully anticlockwise viewed from the front.

Set the meter switch S2 to VOLTAGE and after switching on, advance the voltage control carefully. The voltage output should rise and when the control is fully clockwise, preset VR4 should be adjusted until the meter reads exactly 30V FSD

To calibrate the current reading, switch to CURRENT on the meter switch and connect a load resistor in series with an ammeter across the output terminals. Adjust VR1 until the panel meter reads identically to the external ammeter.

If you don't have another ammeter as a checker, connect a known resistance (say 10 ohm, 3W) across the output terminals and advance the voltage control to provide, say, 5V output (as seen on the voltmeter). The current will now be 0.5A, so switch over to CURRENT and adjust VR1 accordingly. If you don't fancy all this, just replace VR1 with and 18k ohm, 1 percent resistor (0.5W) and the current reading will be sufficiently accurate not ot lose any sleep over.

Current Limit

mit of 1A now has to be set. Turn the voltage control to minimum, switch over to CURRENT, and put a short- circuit across the output. Advance the voltage control so that the meter goes over to FSD or thereabouts, then adjust VR2 until the current is *just below* the 1A reading.

What you aim for is a FSD reading of 1A when the output is shorted — nothing more. If the meter cracks over, you haven't adjusted VR2 properly.

You can, if you wish, set the current limit to any value less than 1A; simply adjust VR2 to give you that limit when the output is short circuited. Like the previous design, the voltage will then not increase above the point at which the current has reached its limiting value.

Continued on page 54

Simple LED Timer

A low cost, easy-build unit that can be adapted to many simple timing applications.

CHRIS BOWES

This project is essentially a variation on the chaser circuit, in which a series of LEDs are made to come on in sequence. This display format has been adapted to provide an indicating function which is used to show an elapsed preset time period. An audible output is triggered when the las LED is illuminated and the circuit is latched so that the alarm continues to sound until the circuit is turned off.

Although the component values have been chosen to suit a timing period of about four minutes, the circuit can be easily adapted so that the period is altered to suit other applications. The author uses his model as an audio/visual egg timer.

The design is intended to operate from a standard 9 volt battery. The circuit shown includes a buzzer but this can be replaced with any of the audible output circuits featured in this series, although it may be necessary to alter the transistor to one of a higher power to ensure that correct operation occurs.

How It Works

The circuit really contains three standard circuit building blocks, some of which we have already met in this series.

The first standard circuit block is the 555 timer astable circuit which is used, in this case, to provide a series of pulses which are used to clock the rest of the circuit through. The standard layout of the 555 timer astable is shown in Fig. 1a and this configuration produces an output waveform as shown in Fig. 1b.

The duration and interval between pulses produced by this circuit are determined by the values of R_A, R_B and C as shown by the two formulas given in Fib. 1b. By altering the values of the components in accordance with the given formulas the timer can be adapted to suit other applications.

The second building block is a standard "chaser" circuit using a 4017 Johnson Counter IC. This very useful IC provides a sequential series of outputs, which are used to drive the indicator LEDs, which change every time a clock pulse is received from the astable circuit.

The IC is provided with a "clock enable" input which is connected to the last output so that when this output is energized the clock is "locked". This provides a latching function which is used to keep the last building block (the alarm) operating until the circuit is switched off.

The final building block is a simple, single transistor current amplifier which is used to provide the current needed to drive

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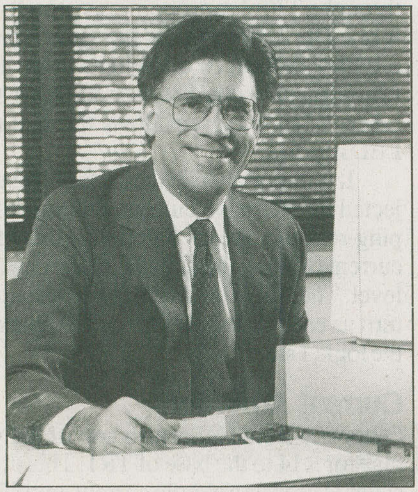

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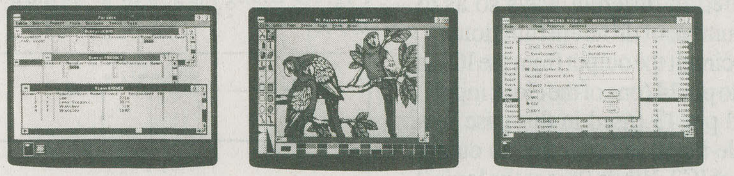

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the output buzzer, which requires more current than could be provided by the Johnson counter.

Circuit Description

The complete circuit diagram for the Simple LED Timer is shown in Fig. 2. The clock pulse required to advance the chaser circuit is provided by IC1, R1, R2, VR1, and C1. This is virtually the same as that shown in Fig. 1a with the combination of preset VR1 plus resistor R2 taking the place of R_B. The addition of VR1 to the fixed resistor enables the time between the clock pulses to be adjusted, for instance, if used as an egg timer it can be calibrated to give exactly the correct time period which is in fact spread over the nine pulses required for the sequence.

Because IC2 is a CMOS device, the bipolar 555 timer can *not* be used in this project and IC1 *must* be the CMOS version, i.e. ICM7555 or TLC555C. There is however, some gain in the fact that the CMOS timer does not require the connection of a capacitor between the 0V power supply rail and pin 5.

The chaser function for the display is provided by IC2, which is a 4017 Johnson Counter. This IC has two inputs which can be configured in different ways so as to provide a number of different functions.

In this circuit the output from the IC1 is connected to pin 14 (one of the clock inputs) of IC2, and pin 13 (used in this case as a clock enable input) is connected to output O_9 (pin 11) of IC2. While O_9 is at the logic 0 (0 volts) level, pin 13 is also held at logic 0.

In this condition the outputs O_0 to O_9 of the 4017 each go to the logic 1 (battery voltage) state in turn, changing every time that the clock pulse at pin 14 changes from the logic 0 state to the logic 1 state (the change going from loci 1 to logic 0 state is ignored) for as long as pin 13 is in the logic 0 state. This continues until O_9 (pin 11) is energized going to the logic 1 state. Because this output is connected to pin 13, which acts as a clock enable input this is also forced to the logic 1 state, causing IC2 to latch in its existing state, keeping pin 11 in the energized state and causing all further pulses at pin 14 to be ignored.

Capacitor C1 and resistor R3 form a very simple pulse circuit which makes the Master Reset input (pin 15) go momentarily to the logic 1 state. This cause the 4017 to be reset so that output O_0 (pin 3) is energized, as soon as the timer is turned on.

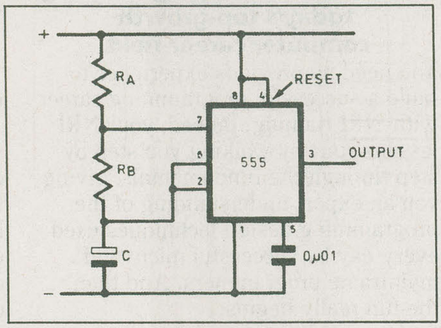


Fig. 1a. Using the 555 timer in the astable mode.

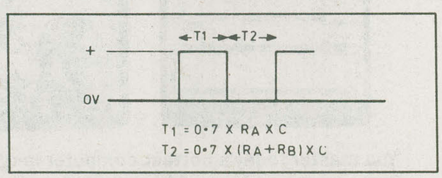


Fig. 1b. 555 timer astable timing diagram.

Display

The ten outputs from the 4017 are each connected to an indicator LED (D1 to D10) through a 330 ohm dropping resistor (R4 to R13). The LEDs work in the same way as ordinary diodes, by allowing a current to flow through in one direction, but not in the other. When a current flows through the LED it glows.

It is important that the LED is not subjected to excessive current and the dropping resistors are included to restrict the current flowing through the LED to a safe level. The LEDs are made to illuminate in turn as each of the outputs of IC2 goes to the logic 1 state.

Current Amplifier

Output O_9 from IC2 is also connected via resistor R14 to the base of TR1. This transistor is used as a simple current amplifier to energize the audible warning device, WD1. When a current is allowed to flow through the base/emitter junction of TR1 it causes a larger current to be drawn through WD1 and the collector/emitter circuit of TR1, causing the buzzer to sound.

Capacitor C3 is a tantalum capacitor which is used to provide smoothing (decoupling) of the power supply rails in all CMOS circuits. This component is necessary to ensure correct operation of the circuit.

Construction

The timer project is easily made up using two stripboards as shown in the photographs and in Fig. 3 and Fig. 4. You

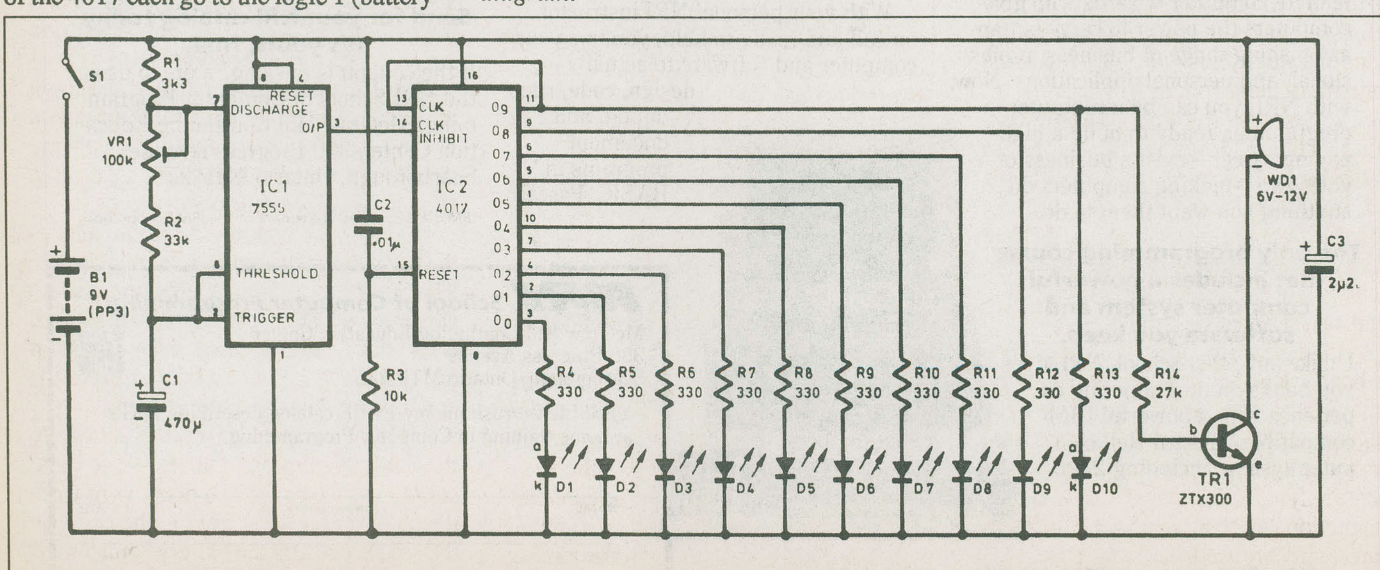


Fig. 2. Circuit diagram for the Simple LED Timer. Diodes D1-10 can be separate LEDs or in a module.

will probably find it helpful to look at those while you make up the circuit.

The first task is to cut two pieces of stripboard to the correct size. You will need one piece, used for the main circuit board, which is 16 strips deep and 29 holes wide and another, used for the display, which is 16 strips deep by 14 holes wide. The sizes allow for drilling 4mm mounting holes in the positions shown, before starting to construct the circuit.

Similarly, before any components are mounted on the stripboards, you will need to break the copper tracks, as shown in Fig. 3 and Fig. 4. It is important that these track breaks are made completely so that not even the merest sliver of copper remains to bridge any tracks.

Although it does not make any difference to the operation of the circuit which order you make up the two boards or which order you insert the components into the boards you will probably find it best to make up and test the display board first and then go on to the main circuit board. The making up of both boards is easier to do if the components are inserted and soldered in ascending order of size.

Display Board

The display board is the simpler of the two boards to make up. The prototype of this project used a ten-way LED module as the display but there is no reason why you should not make use of ten single LEDs instead if you prefer. The first stage of making up this board is to connect the wire links shown Fig.3.

There are a number of wire links required to make the common 0V connection to the LED cathodes (k) and you may prefer to make these connections by means of a single bare wire soldered to the underside of the stripboard.

The next stage is to insert the DIP socket used for the LED display, followed by the display itself. If discrete LEDs are being used, insert them into their correct places and solder them in place. These LEDs are polarity sensitive so it is important to ensure that they are connected the correct way round, or else they won't work.

Also at this stage the wires linking the two boards together can be attached to the display board. Although the board has been designed so that ribbon cable can be used stranded, single-core wire can also be used successfully. If single wires are used then construction will be made easier if different colored wires are used for this purpose.

Testing and fault finding of the timer should be carried out prior to inserting the boards in a suitable case.

Display Board Testing

It is advisable to test the display board separately *before connecting it to the main driver board.* This is simply done by connecting the negative of the battery to the *common* connection on the board and touching *each* of the wires connected to the anodes (a) of the LEDs, via the associated dropping resistors to the positive connections of the battery in turn.

Each LED should light up as the connection is made. If none of the LEDs light up then the most likely causes are either that the 10-way LED module (if you are using one) is inserted into its holder the wrong

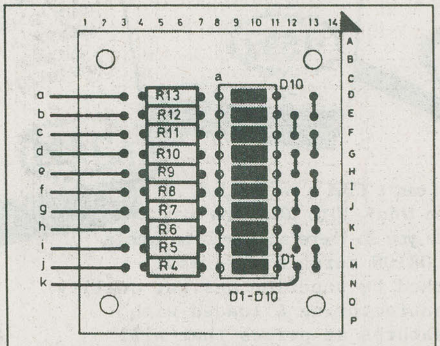
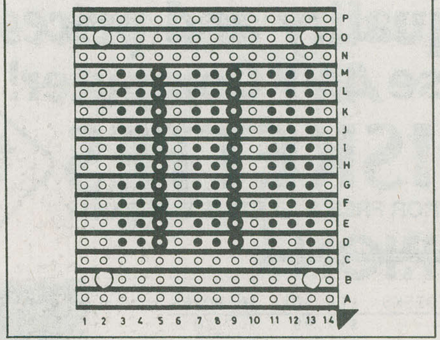


Fig. 3. Display board component layout and track cuts.



way round or that there is a faulty connection in the common wire connecting all the cathodes (k) to the battery negative.

The first fault can be cured by rotating the module through 180 degrees. The second fault will have to be traced by testing the continuity (using the meter's "ohms" range) between the battery end of the common wire and its connections on the board.

If some of the LEDs light but not all then it will be first necessary to check whether there is a pattern as to which diodes light and which do not. If there is a point in the sequence up to which they light and then the rest do not then it is likely that there is a break in the links joining the commoned cathodes together. This can be traced as described above.

If there is no pattern as to which LEDs light and which do not then it is most likely that there are individual faults in each of the circuits leading to the anodes of the LEDs via the associated series resistor. The complete circuit, from the wire leading to the main board, through the series resistor and the connection to the anodes should be thoroughly checked with a meter to ensure complete continuity of the circuit. If neither of these checks reveals any explanation as to why a correctly installed LED does not light then it must be assumed that it is faulty and should be replaced.

Main Board

After the display board has been made and checked it is now time to construct the main board, starting by inserting the wire links as shown in Fig. 4.

The next task is to put the resistors in their correct places by first bending the wires of the resistor at right angles to the body of the component, so that they will fit through the holes, as shown in Fig. 4. Also fit preset VR1 into the correct position and solder it into place.

The next item to be inserted into position is the IC holder. Although it is possible to solder the IC directly into place using a socket will both make the construction simpler and make for easier replacement if a fault should occur. It is important that you take care to make sure that the notch on the IC holder is facing towards the bottom of the stripboard as this will help you when inserting the ICs into place.

Next come the capacitors. C2 is a non-polarized capacitor so it does not matter which way round it is inserted by C1 and C3 are electrolytic capacitors so it is important that they (the -ve connection usually marked on the component case — see photographs) are connected as shown in Fig. 3. Similarly care must be taken when mounting the transistor to ensure that its orientation corresponds with that shown in Fig. 3 and the photographs.

The final component to be mounted is the buzzer or other audible warning device. This device if often polarity sensitive so care must be taken, if the device is marked with polarities on the case or by means of red and black colored wires, to make the connections with the correct polarity.

The wires connecting the battery to the circuit board can then be tinned and soldered into place. The black wire from the battery connector goes to the point on the stripboard and the battery connector's red wire will need to go to one of the switch terminals. Another wire is con-

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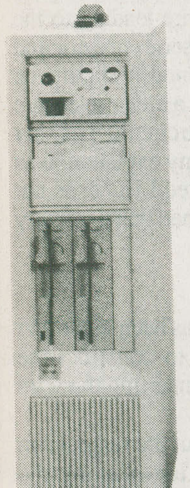

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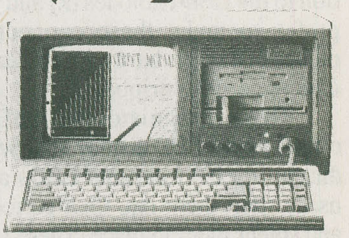

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nected between the other switch terminal and the B1+V connection on the stripboard. The tested display board can now be connected to the main board taking care to ensure that the connections match exactly those shown in the board layouts.

The final step is to insert the ICs into their holders, making sure that the notch or indentation on the IC corresponds with the notch on the IC holder. Some ICs do not have a notch in one end but have a slight, circular dent near pin one.

Main Board Testing

Before connecting the battery and testing the circuit you should carefully examine the stripboard to make sure that all of the components are inserted into the correct places, are the correct way round and that there are no blobs of solder shorting out the tracks. Once the board has been checked then the battery should be connected and you should be able to see the LEDs turning on in turn and be able to set the rate of this by adjusting VR1.

If the circuit does not operate correctly it will be necessary to check for faults. You will probably find that you will need the aid of a multimeter to perform this stage of the process.

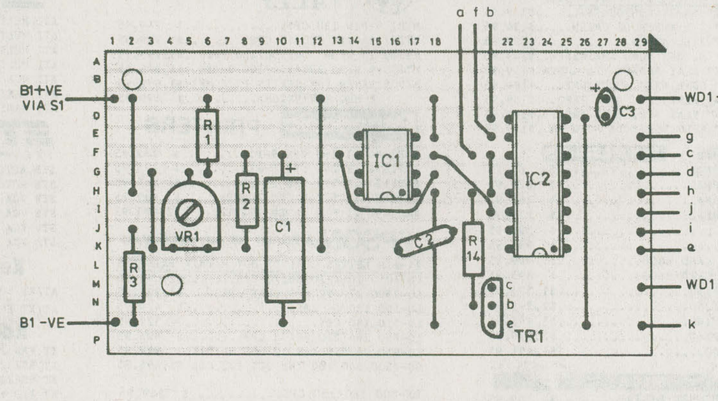
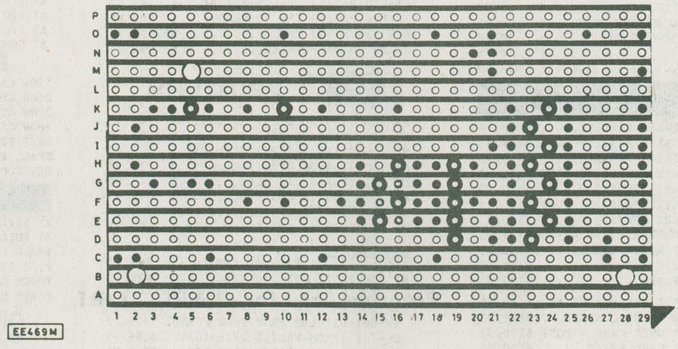


Fig. 4. Main stripboard component layout and details of track cuts.



Clock Generator

Check that the clock generator circuit, comprising R1, VR1, R2, C1 and IC1, is operating correctly. The best method of doing this is to use a voltmeter to measure the output voltage at pin 3 of IC1. If the clock circuit is operating correctly then the meter needle should be seen to register a slow pulse at approximately 30 second intervals.

If this does not happen then the next stage is to perform some basic voltage checks. You should be able to measure the battery voltage between an 0 volt connection and both pins 8 and 4 of IC1 as well as between the Battery+ connection to the board and pin 1. If these voltages are not present this will indicate faulty wiring up of the stripboard.

If this does not produce a satisfactory solution then the output voltage at pin 3 of IC1 should be checked. If this is locked permanently at a fixed voltage then you should remove the IC from its socket and check the voltage at pin 3 connection again. If the voltage persists with IC1 removed then the fault does not lie with IC1 but possibly with the wiring associated with the IC and the output to IC2 or its associated wiring.

The next step is to replace the IC and check the voltages at pins 2, 6 and 7. The voltage at pin 7 should be fluctuating slowly around a value which is roughly between 1/3rd and 2/3rds of the battery voltage. The voltages ate pins 2 and 6 should be identical (because these two pins are connected together by a wire link) and these should also be fluctuating but at a voltage slightly less than that found at pin 7.

If both of these voltages are not present then the most likely cause is that the circuit from the + voltage rail, through VR1, R1 and R2 is not correctly made. This is best checked by measuring the voltage present between 0 volts and each of the points in the component chain through VR1, R1, R2 and C1 and investigating at the junction where no voltage is measured.

If no voltage is present between 0 volts and pin 7 but no voltage, or only a very small voltage, is measured between the 0 volts rail and pins 2 or 6 of IC1 then you should check that the resistance between pins 7 and 6 of IC1 is roughly equal that of resistor R2. If this is correct then check the resistance of capacitor C1 with the resistance range of your meter.

If the resistance is very low (less than about 500 ohms) then you should replace C1. If there is no voltage measurable between pins 6 and 2 of IC1 then this could be caused by a short circuit between the connections of C1 or by a short circuit within C1 or its connections to the stripboard.

If voltage is present at pins 2 and 6 of IC1 but it does not fluctuate then the likely causes are that C1 is not correctly connected, is faulty or that IC1 is faulty. To check C1 you should touch connect another capacitor of similar value across the connections to see if this cures the fault. If this does not cure the fault check that the connection between the positive connection of C1 and pins 2 and 6 of IC1 is correctly made.

Counter

If voltage switching is taking place at the output of IC1 then the IC is working correctly and the fault is most likely to lie in the area of IC2 and its associated components. The first stage is to check that the power supply is correctly connected to pins 8 and 16. In case this voltage cannot be measured then you should check the connections to pin 8 and 16 and ensure that the wire links have been correctly made.

The next stage is to check that the clock pulses from pin 3 of IC1 are being correctly received at pin 14 of IC2. As these pulses are somewhat slow you may find it helpful to replace capacitor C1 with a lower value capacitor at this stage.

If the clock pulses are being correctly received at pin 14 of IC2 then it is necessary to check that pin 15, the master reset input, is at logic 0. If a logic 1 state exists at

this point the circuit will be locked with output O_0 permanently in the high state. If a logic 1 state is found at pin 13 then you should check very carefully for solder bridges between pins 15 and 16 of IC2.

If the clock pulses are being received at pin 14 and pin 15 in the logic 0 state, then the counter should advance by one for every clock pulse received, provided that pin 13 (the count enable input) is in the logic 0 state. Because this pin is connected to pin 11 of IC2 then the counter should advance until pin 11 is forced to the logic 1 state.

Now check the logic state of pin 3, which should be at logic 0 (0 volts). If the logic state at pin 13 is logic 1 or an indeterminate logic state then the connections between pins 13 and 11 (which is a wire link) should be carefully checked.

If this connection is correct, with no accidental connection between either of these pins and the battery supply line, then the states of the output pins of IC2 should be checked. You should find that only one of the outputs (pins 1, 2, 3, 4, 5, 6, 7, 9, 10 and 11) should be in the logic 1 state and all other outputs should be in the logic 0 state.

Immediately the device is switched on pin 3 should be at the logic 1 state. If this is not the case then the problem may possibly be that the master reset input (pin 15) is not receiving a quick reset pulse from the circuitry made up of capacitor C2 and resistor R3. The connection between the battery supply rails and these two components as well as that between the junction of R3 and C2 and pin 15 of IC2 should be checked.

If more than one of the outputs is in the logic 1 state then one must suspect that IC1 is faulty and must be replaced. Assuming that the LED display board has been checked and connected up to the main board beforehand then the states of these outputs may be monitored by observing the illumination of the LEDs on the display board to the main board. If more than one LED lights at the same time then the connections between the ribbon cable joining the display to the main stripboard should be carefully checked to ensure that there are no solder bridges between adjacent tracks.

Alarm

The final part of the project to check is the alarm. This is very simple since it comprises a resistor, a transistor and an audible warning device. If the audible warning device does not sound when the last LED is illuminated then the circuitry associated with TR1 should be checked.

An initial test is to short out the emitter and collector of TR1, with a small piece of wire, and see whether the audible warning device sounds. If this produces no effect then WD1 should be inspected to ensure that it has not been connected with the wrong polarity. If the polarity is correct, the connections from the positive power supply rail to WD1 and from the warning device to the collector of TR1 and from the emitter of TR1 to the strip carrying the battery negative connection should be checked.

PARTS LIST

Resistors

R1 .... 3k3
R2 .... 33k
R3 .... 10k
R4 to R13 330
R14 .... 27k
All 0.25W 5% carbon.

Potentiometer

VR1 .... 100k min. preset, horiz.

Capacitors

C1 .... 470u elec. 10V
C2 .... 0u01 mylar 16V
C3 .... 2u2 tantalum 10V

Semiconductors

D1-D10 10-way bar LED array (or 10 single LEDs)
TR1 .... ZTX300, 2N3904 NPN
IC1 .... CMOS 7555 timer
IC2 .. 4017 10-stage Johnson counter

Miscellaneous

S1 .... SPST switch
WD .... 6V-12V solid state buzzer
B1 .... 9V battery

Stripboards, 17 strips X 29 holes (main board) and 16 strips X 14 holes (display); 16-pin IC socket; 8-pin IC socket; plastic case; self-adhesive stand-offs; battery connector; connecting wire; solder, etc.

If the audible warning device is working correctly then the operation of the transistor can be checked by making a temporary link, with IC2 removed from its socket, between pins 16 and 11 of IC2. This should produce a battery voltage measurable between the end of resistor R14 furthest away from the base of TR1 and 0 volts. If this does not occur then the connection between pin 11 and the IC end of R14 should be investigated.

With a battery voltage present at the junction of resistor R14 and pin 11 of IC2, a voltage of approximately 0.7V should be measurable between the base and the emitter of transistor TR1. If no voltage is measurable here then the resistance of R14 should be measured to endure that it is actually acting as a resistor and not an open circuit. If this does not produce a resistance reading, close to the value specified for R14 and TR1 is connected the correct way round, then TR1 must be suspected of being faulty and should be replaced.

Case

This project has been designed to fit inside a case. The first stage of preparation of the case is to cut, carefully, a hole in the case lid, the correct size to accommodate the LED display. This should be carefully measured, taking into account the need to allow for stand-offs into which the mounting holes on the stripboard containing the display will fit. For this reason the positioning of the display should be done with some care. It is also necessary to drill a hole in the case lid to accommodate switch S1. Once the necessary holes have been drilled in the case lid it can then be lettered and the lettering protected with several layers of clear, spray on varnish.

Self adhesive stand-offs should be mounted on the component side of the display board and the board offered up to the inside of the case lid. When the display is correctly seated in the hole cut for it then the pads may be pressed firmly into place to hold the board in the correct position.

Self adhesive stand-offs can also be fitted to the main board (with the pads on the track side this time). The main board can be offered into place and the self adhesive pads pressed firmly onto the bottom of the case to hold the stripboard into the correct position. The battery can now be replaced in the battery clips, the circuit tested and preset VR1 adjusted to give the correct timing period before finally screwing down the case lid.

In Use

The timer is very simple to use. All that is necessary to do is to operate switch S1, at which point D1 will come on. The remaining LEDs will then come on in order, at approximately half minute intervals, until D10 is illuminated at the time that you have preset by adjusting VR1. When D10 comes on the audible warning device will sound and will continue to sound until S1 is switched off. ■

FEATURE

Techie's Guide to C Programming Part 12

This month we're going to find some practical uses for all the file access facilities we've been investigating in the previous two installments of this series. We're going to see how a database manager operates.

STEVE RIMMER

The better you understand disk file access, the less mysterious a lot of programs will probably become for you. Several broad classes of applications software rely on forms of file manipulation, and many others seem to do the impossible because their authors thought of clever ways to make files work.

The word processor I'm using to write this article, for example, will edit a file which is larger than the memory in the computer it's running on. It does this by using what has come to be called "virtual memory". It keeps the current part of the file in a small memory buffer and "spills" the rest of it on and off the disk as is required.

It may seem difficult to think of memory and disk space as being similar quantities, but in many respects they are. Using the file management facilities we've discussed thus far, it's possible to seek around in a file in the same way that we might use pointers to access areas of memory. Of course, moving data in and out of a file is a lot slower than equivalent memory operations... software which uses virtual memory techniques must do so with some forethought, lest it slow to a crawl every time it goes to alter its data.

A "stock" PC compatible computer can only address 640 kilobytes of useful system memory. The rest of its one megabyte address space is tied up with various memory mapped oddities like the screen buffer and the system BIOS. When you load DOS and a sizeable application program into that available memory, you might well find that all you have is a few hundred kilobytes left. If the application program in question deals with large amounts of data, it will probably find itself a bit cramped.

Loss of Memory

The picture in Figure 1 is a black and white version of a public domain "GIF" image. GIF images are full colour computer graphics which can be displayed on a VGA monitor. This one is 800 by 600 pixels across. Each pixel requires one byte. If you whip out your pocket calculator you'll discover that this picture requires 480,000 bytes of memory to store it.

A program which was confronted with the task of doing something with this picture might be faced with a problem. Unless the program was very tiny indeed... and hence didn't do very much... it would tie up enough system memory to

make allocating a buffer big enough to store the picture impossible.

The designer of the program in question would thus have several options. One of them would be to use extended or expanded memory, preferably the former, as it's faster. Extended memory allows users of AT and 386 computers to put up to 16 megabytes of additional memory in their computers, memory which is useless for running programs in, but is good for storing data. This is the sort of applications which extended memory is ideal for.

Unfortunately, in writing commercial software which relies on extended memory, one is immediately making one's software inaccessible to users of straight PC compatibles... which can't support extended memory... as well as to AT and 386 users who don't happen to have any extended memory installed in their machines.

There is a second option. Rather than writing the decoded GIF image to memory... of which there isn't enough... we could write it to a big disk file. If the program in question wanted to print the picture to a laser printer, for example, it could then retrieve the lines of the picture one at a time, making the memory requirements for the process pretty tame.

The process for locating the lines would be simple, and you can probably see how it's going to work if you recall last month's discussion of files and seeking. Allowing that the picture is *x* bytes wide and that we want to read line *n* into a buffer, *b*, we would do this. We'll assume that *fp is a handle to the file with the image data in it.*

```
fseek(fp,(long)x * (long)n,SEEK_SET);
fread(b,1,x,fp);
```

The *fread* function is used to read raw data into a buffer.

The reason for casting both the size variables to *long* will be discussed in a moment.

With this arrangement, the only memory requirements of the application software in question would be a buffer six hundred bytes long to hold one line of the image at a time.

This approach has two principal drawbacks. The first is that it assumes that its users will have about half a megabyte of disk space available to hold the big temporary image file. In reality, it assumes there will be this much hard drive space on hand... virtual memory is too slow to think about on floppies. The other drawback is that even with a hard drive this will be a lot slower than using memory would have been.

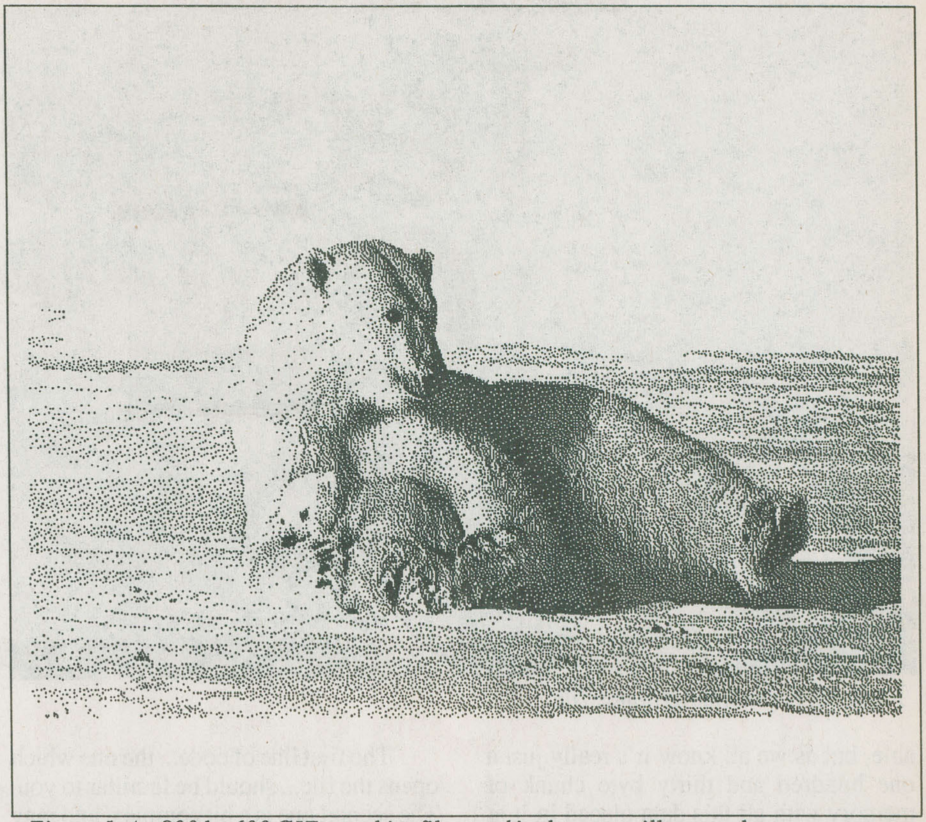


Figure 1. An 800 by 600 GIF graphics file, used in the text to illustrate how memory copes with extra-large files.

On the other hand, it's better than not working at all.

Commercial software which uses lots of memory usually has a multiple option approach to it. If a program needs a big buffer, it might start by checking for sufficient regular DOS memory. If that fails, it will check for the presence of extended memory, using that if it's available. Finally, it will try using a disk file. Programs such as Microsoft Windows do a lot of virtual memory operations to create the illusion of having unlimited amounts of memory for applications.

Shift That Data

A database manager is a very simple sort of virtual memory task, one which is easy to understand. A database is simply a collection of structs, in C terms, written to a file. However, the file can be of any size so the database manager cannot assume that it can simply read it into memory and work on it there. It must deal with its data as virtual memory.

A mailing list is a good example of a typical data base. Each name and address on the list can be thought of as one *record*. Each record contains several *fields*. We might represent a record in C language terms like this.

```
typedef struct {
char first_name[25];
char last_name[25];
char street_address[37];
char appt[16];
char city[16];
char province[3];
char postcode[8];
} MY_RECORD;
```

This struct occupies one hundred and thirty bytes. You can write this into a C language program very conveniently with the expression

```
sizeof(MY_RECORD);
```

This expression would return 130.

We could declare a variable of the type MY_RECORD and fill it like this.

```
MY_RECORD r;
strcpy(r.first_name,"Augustus");
strcpy(r.last_name,"Robes");
strcpy(r.street_address,"14 Dead Pharaoh Parkway");
strcpy(r.appt,"6 1/4");
strcpy(r.city,"Bentfoot");
strcpy(r.province,"ON");
strcpy(r.postcode,"L4T 4A5");
```

Having done this, the variable *r* is loaded up with all this data. C would like us to treat this as a MY_RECORD vari-

Techie's Guide to C Programming, Part 12

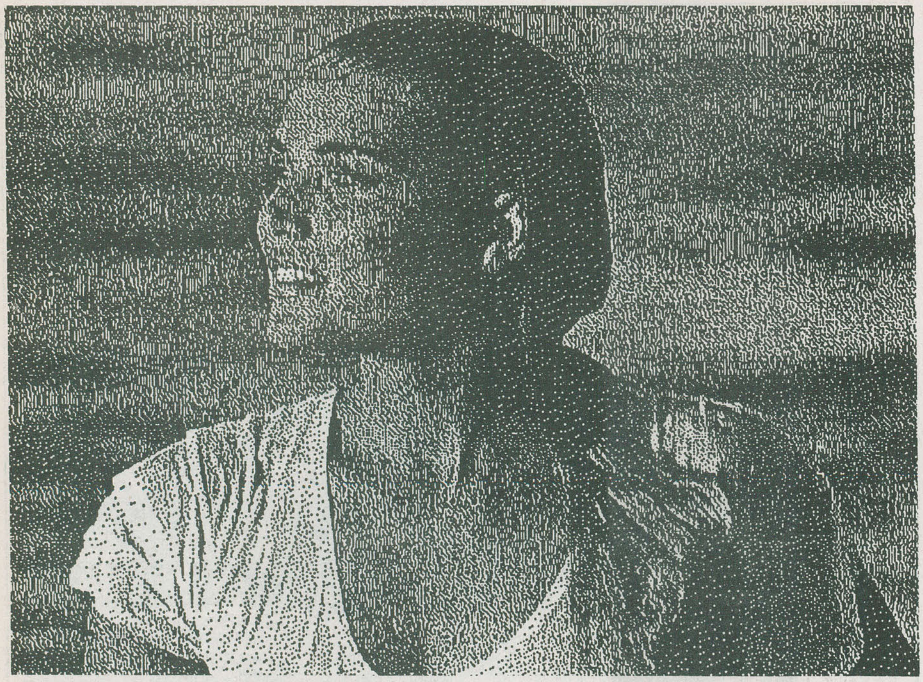


Figure 2. Yet another graphics file.

able, but as we all know it's really just a one hundred and thirty byte chunk of memory with all this data placed in it at strategic locations.

Under C, as you will recall, variables of one type may be *cast* to variables of another providing that their base types are somewhat compatible. What this really means is that in this one particular case you'll be telling your C compiler that you want to break the type checking rules it has set up but that you're doing it explicitly and you take the responsibility for any consequences which might result from your action. We may, for example, cast a variable of the type MY_RECORD to a *char* buffer because we know full well that that's all *r* really is.

This rather obtuse expression illustrates the syntax for this cast.

```
(char*)&r;
```

Here is a simple bit of C code which will create a database file called MYFILE.DAT and write the above record into it as the first record. We'll assume that *r*, above, has been declared and filled with data.

```
FILE fp;
if((fp=fopen("MYFILE.DAT","wb"))!=
NULL){
fwrite((char
*)&r,1,sizeof(MY_RECORD),fp);
fclose(fp);
}else puts("Can't create the file");
```

There's a lot of strange stuff going on in here.

The first line of code... the one which opens the file... should be familiar to you. The second one is a bit complex, and may not be.

The *fwrite* function, like the *fread* function mentioned above, is used to deal with blocks of raw data which move in and out of files. It's usually used with files which have been opened in binary mode, as this one has. Notice the *"wb"* argument to *fopen*.

There are four arguments to *fwrite*. The first one is a pointer to the *char* buffer which is to be written from. In this case, we don't have real a char buffer... we have a synthetic one cast from a MY_RECORD variable, as discussed a moment ago. You will note that the casting syntax is the same.

We could have handled this a bit more readably by doing something like this.

```
char *p;
p=(char*)&r;
fwrite(p,1,sizeof(MY_RECORD),fp);
```

In this case we have explicitly cast *r* to the *char* variable *p* and then written the data from the pointer rather from the buffer which it points to. The results are exactly the same... this approach might be a bit easier to understand, although it uses one more line of code than is really required.

The second argument to *fwrite* represents the size of the objects being written in bytes. The third represents the number of objects to write. In this case we have told *fwrite* that the objects are one byte long and there are one hundred and thirty of them, this being the size of a MY_RECORD struct. We could have reversed these arguments, that is, we could have told *fwrite* to write one object which is one hundred and thirty bytes long instead of one hundred and thirty objects which are one byte long.

The last argument to *fwrite* is the file pointer for the file being written to.

If the write is successful, *fwrite* will return the number of objects which have been written, the value one hundred and thirty in this case. If something goes wrong, such as the disk proving to be full before the entire struct could be written to it, *fwrite* will return the actual number of bytes which made it into the file.

You would check for errors in *fwrite* with the following code.

```
if(fwrite((char*)&r
,1,sizeof(MY_RECORD),
fp)==sizeof(MY_RECORD)){
puts("Written ok");
}else puts("Write error");
```

Bigger Files

Let's now suppose that MYFILE.DAT has acquired the entire mailing list of Publisher's Clearinghouse. It's many hundreds of thousand of records long, teeming with people who don't want to be there even though they may already have won millions of dollars, cars, trips and subscriptions to trashy magazines. Each of these hapless souls is represented by one record structured as a MY_RECORD variable.

The folks at Publisher's Clearinghouse have discovered that Augustus Robes, famed Egyptologist and sample datum, sought to fool them by giving them the wrong post code. For the past four years all his junk mail has been winding up in a home for retired cat skinners in Thunder Bay. Swearing under their breath, they find Mr. Robes' record number from one of his old mailing labels and set about changing his post code.

One may assume that Publisher's Clearinghouse has a very sophisticated database manager to do this sort of thing, but the process would work pretty much like this. We'll allow that the record which stores Augustus Robes' information is record 10967.

To begin with, we need a function to read records from the file. All of the information about Augustus Robes is correct except for his post code, and we do not wish to have to enter everything anew. As such, we would use this function.

```
read_record(fp,record_number,r)
FILE*fp;
unsignedintrecord_number;
MY_RECORD*r;
{
fseek(fp,
(long)sizeof(MY_RECORD)*
(long)record_number,SEEK_SET);
fread((char
*)r,1,sizeof(MY_RECORD),fp);
}
```

There are a few important things to say about this function. First off, it allows for no error checking, which it would do in a real world application. Second, you will notice that the syntax for the cast in *fread* is a bit different. You would fetch the record in question by using this function as follows.

```
MY_RECORDr;
read_record(fp,10967,&r);
```

As you will recall from several months back, structs cannot be passed by value, only by location. We pass a pointer to the struct *r* rather than *r* itself. As such, having used the *&* operator in passing the thing, we need not use it in the cast within the function. The variable *r* withing the function is not a MY_RECORD variable but a MY_RECORD pointer.

Finally, note that we cast each of the numbers being multiplied together to *long* before performing the calculation. This is a subtle but very important point. If you multiply 10967 by 130 as long integers, you will get the correct result, 1,425,710. This is the position in the file where Augustus Robes' record begins. However, if you multiply them together as straight *ints* and then cast the result to long, the result will be 49,475. This happens because the result of the calculation will be limited to sixteen bits.

In the real world, one might assume that Publisher's Clearinghouse has so many records in its database that it must use long integers to express their record numbers.

Having executed *read_record*, above, the *r* variable will have all of the information about Augustus Robes, including his erroneous post code. We would change this one item,

```
strcpy(r.post_code,"L9G1Q4");
```

and then write the record back to the file. The function to do this looks pretty much like the one to read it.

```
write_record(fp,record_number,r)
FILE*fp;
unsignedintrecord_number;
MY_RECORD*r;
{
fseek(fp,
(long)sizeof(MY_RECORD)*
(long)record_number,SEEK_SET);
fwrite((char
*)r,1,sizeof(MY_RECORD),fp);
}
```

It would be called in much the same way too.

```
write_record(fp,10967,&r);
```

These two functions are the basis of any fixed field database manager, that is, of any program which treats its data records as hard wired structs. You can apply them to all sorts of database applications. For example, suppose that the Publisher's Clearinghouse people found out that Augustus Robes had fooled them but they did not know which record his data was kept in. They could do something like this to find him. We'll allow that the variable *max_record* holds the number of the last record in the file.

```
MY_RECORDr;
inti;
for(i=0;iax_record;++i){
read_record(fp,i,&r);
if(strcmp(r.first_name,"Augustus")==0
&&
strcmp(r.last_name,"Robes")==0){
printf("The record number of %s %sis
%d\n",
r.first_name,r.last_name,i);
break;
}
}
```

Record Time

Obviously, the examples in this article have been a bit simplistic. If you go to write a database manager of your own using them you will want to add some error trapping and, more important, a user interface. In the real world one would not write a custom C program every time there was a need to locate a specific record.

The database manager illustrates a fundamental use of disk files as a way to handle large amounts of structured data. A database manager is really just a slightly more complex version of the picture file we discussed at the beginning of this feature. However, it points up a simple rule of data files. As long as the data is structured in some predictable way, you can handle it as a series of fixed records and, as such, access it fairly quickly.

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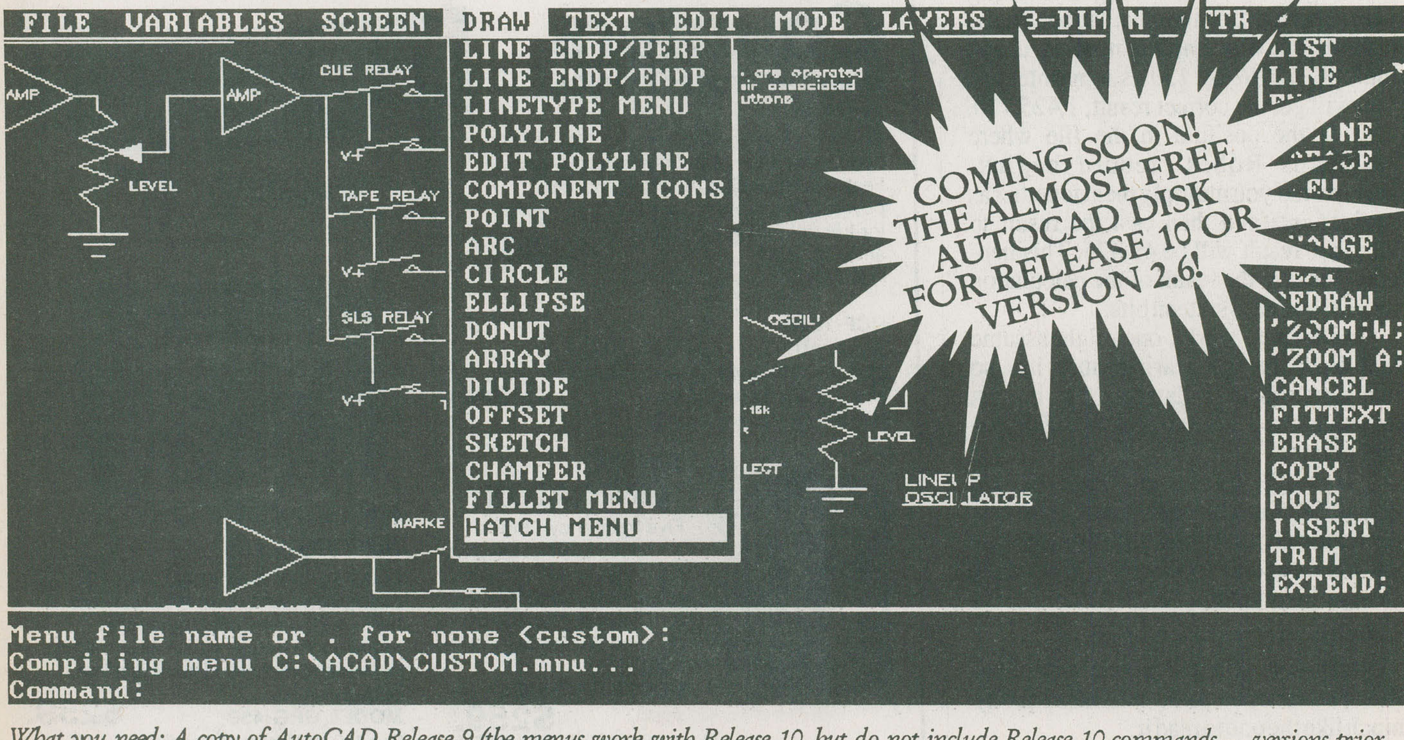

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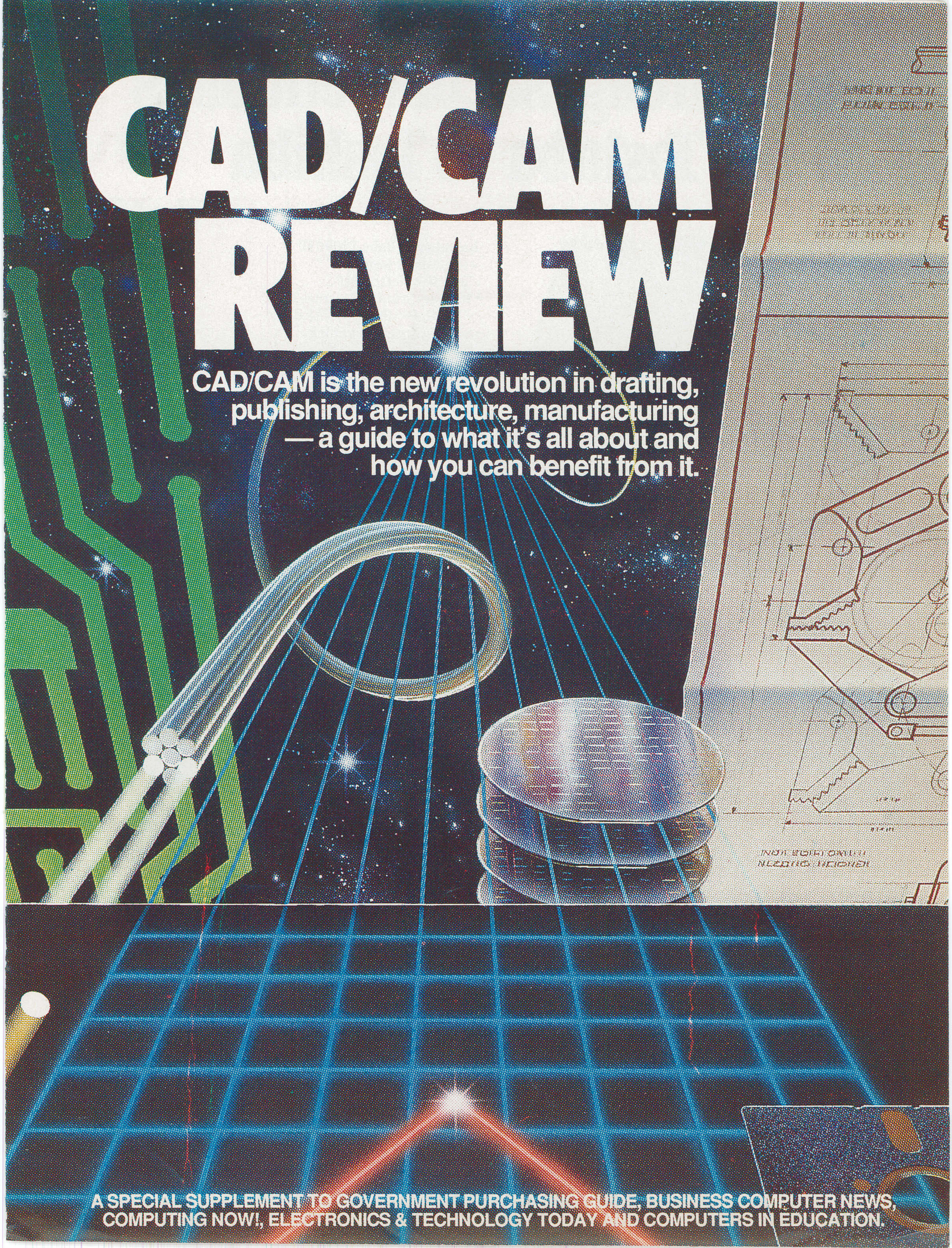

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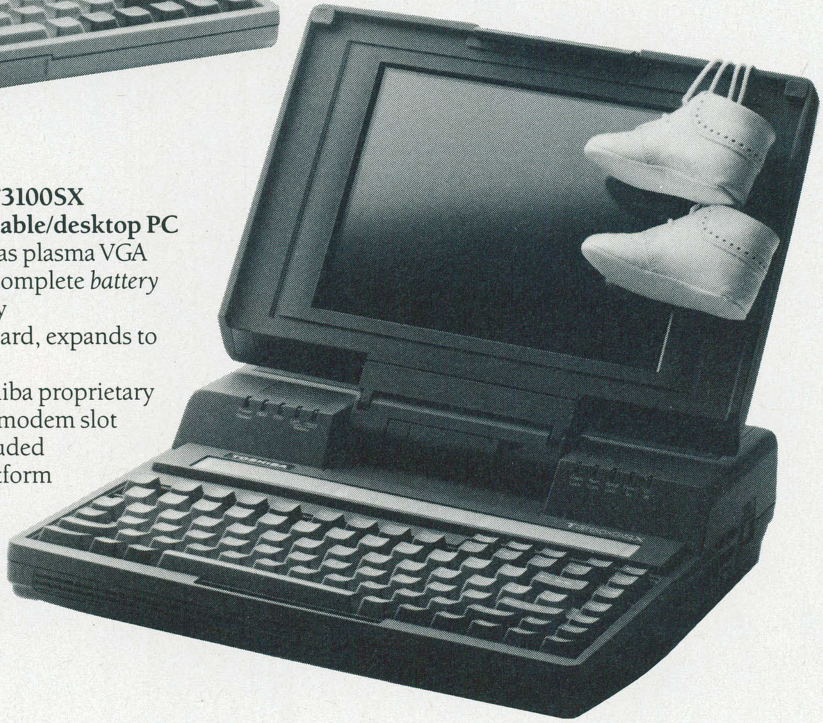

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3D CAD Software

Is 3D really necessary? A look at some of its features.

Text and Auto CAD drawings by Bill Markwick

In his book *The Autodesk File*, co-founder John Walker mentions that the development of 3D for AutoCad was spurred along because it made such a wonderful demonstrator for dealers and trade shows. A drawing that was revolving in 3D space was any number of times better than fancy zooms and pans. Despite this somewhat commercial beginning to 3D CAD on the PC, three- dimensional software is now everywhere, offered by just about everyone in the business. But drafting has traditionally meant the two-dimensional approach of pencil on paper, or cursor on monitor — drafting and design personnel might well say "It's a dynamite toy, but what is it *for*?"

3D is no longer just for hooking the rubes at trade shows. It's a valuable tool for product designers, architects, engineers, production managers, etc. Here's a look at some of the things it can do.

The Big Picture

The standard 2D drawing is unexcelled for communicating a wealth of details and assembly procedures, as in the drawing of the valves in Fig. 1. CAD systems are great for this: for instance, the left valve is simply a copy of the right one, with suitable changes edited in. One of the beauties of CAD is that you never have to draw anything twice.

The drawbacks come when you have to do multiple views, as you would when explaining the installation of any complex devices or systems. This is one of the advantages of 3D; although the initial drawing time is very long compared to 2D, you can plot out any number of views at any angle or magnification, in wireframe (X-ray) views or hidden renderings. Fig. 2 shows a heating system installation overall view; suitable text labels could be added to show types of pipe, special routing, and so on.

Details

To show details that are hidden by the standard 2D rendering, the drawing can be rotated and magnified until you see what you want. Fig. 3 shows the rear of the radiators, as though you could look through the walls. This view took only a few minutes to display and plot.

In Fig. 4., a zoom has magnified one corner of a radiator, and specific details have been added; it can be saved as a separate file if the extra detail is slowing down the regeneration time of the main drawing.

The three views of the heating system demonstrate just how much time you can save, as well as the tremendous flexibility of the 3D approach.

Architectural

The above techniques lend themselves perfectly to the needs of the architect. In Fig. 5 is a 3D hidden-line rendering of a proposed house floor plan. This is only one of the infinite views possible, but it allows the architect and client to preview the layout to see how it works. In Fig. 6 is a rotated view of the floor plan without hidden line removal. This lets you see all the features at once.

Although you can't tell from the drawings

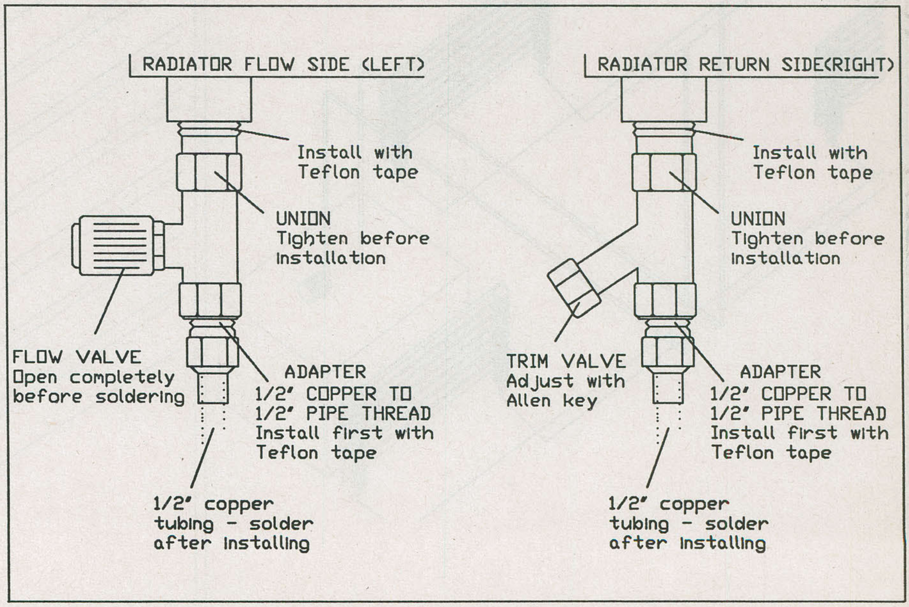


Fig. 1. The traditional 2D rendering contains a wealth of information, but no other viewpoints are possible.

in Fig. 5, there's a wealth of technical information along with the architectural renderings. By turning on various layers of the drawing, you can display any or all of the plumbing, wiring, heating, dimensions, constructional details, etc. For instance, in Fig. 6, I've turned on all the details and turned off the furniture and fixtures. This drawing could be zoomed for better display, or plotted as a plan view for working drawings, or used to calculate the required lengths of wires, pipes, etc. I even made a layer that calculates the number of sheets of drywall needed.

Special Views

Figure 7 demonstrates how 3D CAD can take drawings another step further. The 3D drawing, which is really a database, can be fleshed out with auxiliary software (in this case, AutoShade); multiple views from various viewpoints can be printed out or displayed on the monitor to show clients what the final result will be from the inside of the house.

Figure 8 is a demonstration of an industrial object in multiple, simultaneous viewpoints. The designer can create, change and shade the design, all before any tooling is done. In addition, the drawing

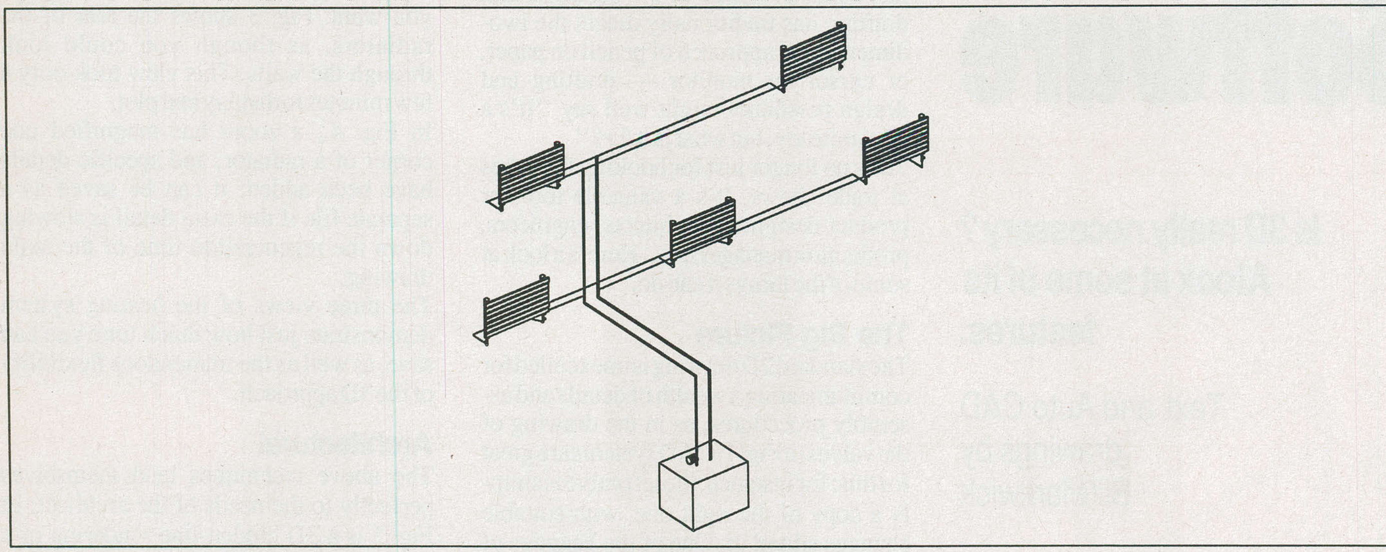


Fig. 2. This 3D view of a heating system can show the pipes, valves, radiators, etc., from any angle.

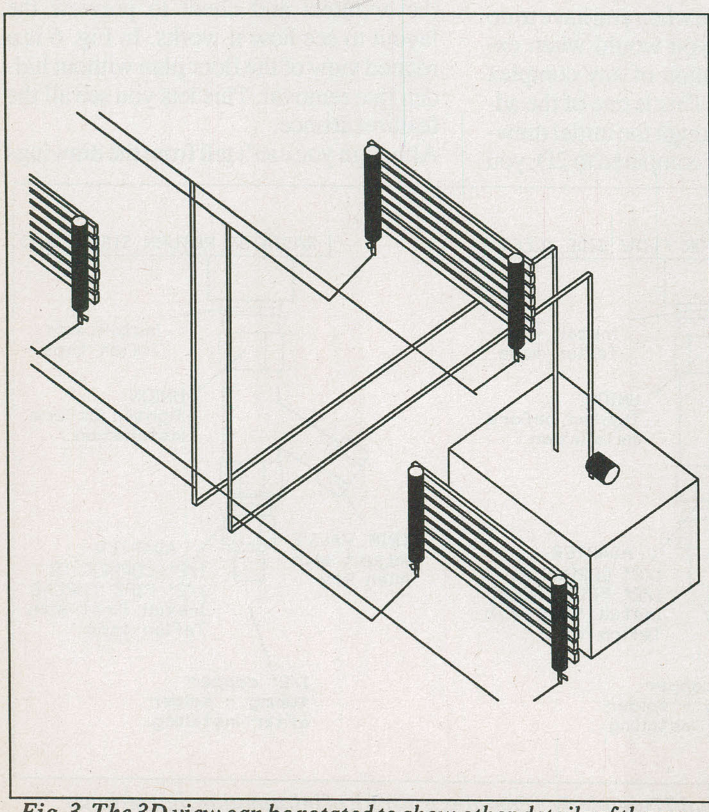


Fig. 3. The 3D view can be rotated to show other details of the system from any angle, saving much redrawing.

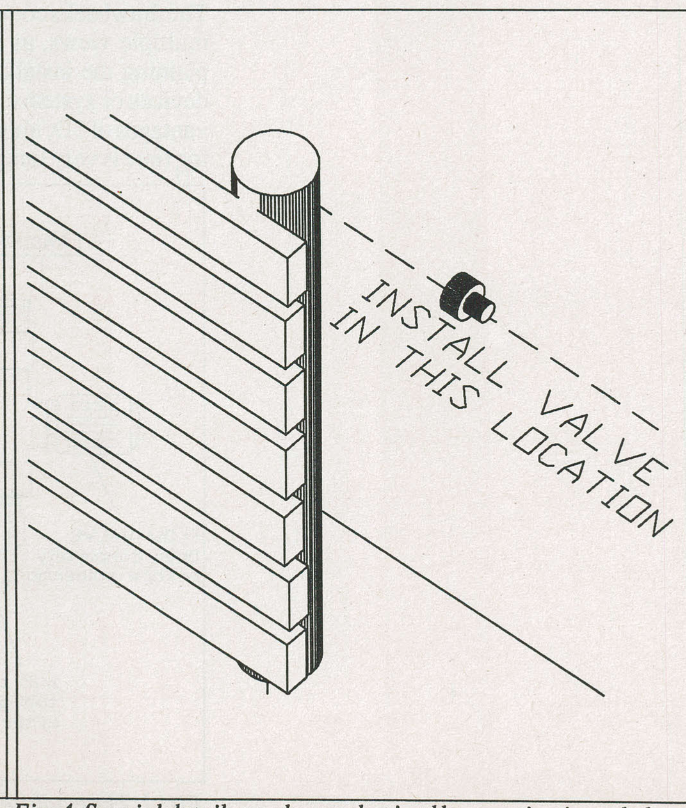
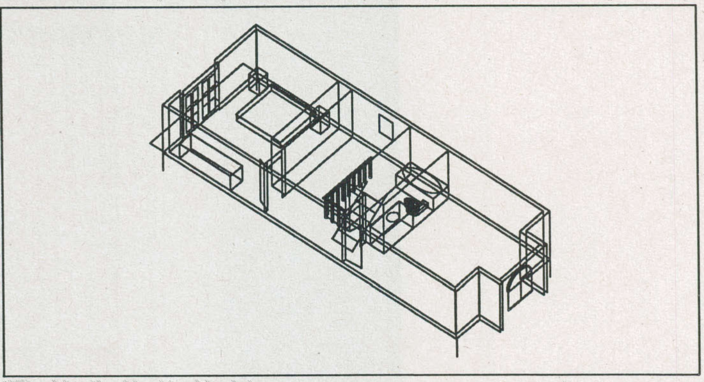


Fig. 4. Special details can be emphasized by zooming in and plotting a hidden-line view.



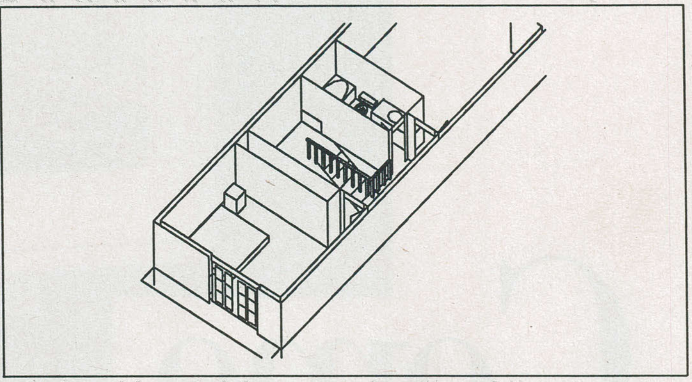


Fig. 5. The architect can plot a 3D drawing in any number of angles, in both hidden-line and wireframe views, allowing clients to see the final results before any expensive construction

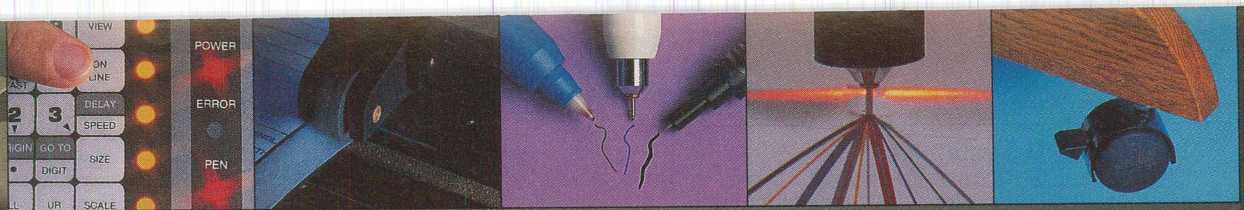
database can be manipulated by auxiliary software to produce control instructions for milling machines, turning the drawing into reality with a minimum of setup time.

Reality

There's no doubt that 3D is difficult to learn, with its need for the operator to visualize designs in a new way. Anyone who's tried 3D CAD will have experienced the common optical illusion that the cursor is exactly where you want it, except that anything you draw ends up floating in space a long distance from where it should be. The cures for this depend on the particular software; usually it means learning some sort of coordinate system designed to let you move around in 3D space without losing your way.

Another drawback is that the complexity of the drawing slows down the regeneration time; the computer takes longer and longer to redraw the image when you zoom and pan. When it comes to hidden line removal, you may be in for hours of waiting with a large file. The same goes for shaded renderings. If you plan to do full 3D more than occasionally, one of today's faster computers becomes a necessity. For instance, in the DOS world, a 12MHz AT or compatible is entry-level.

Although full 3D drawing creation takes a long time (and in the beginning, it seems to take *forever*), it only has to be done once in order to provide all sorts of features that each used to require separate projects. In the long run, the time saved and the flexibility will more than make up for the slow start.



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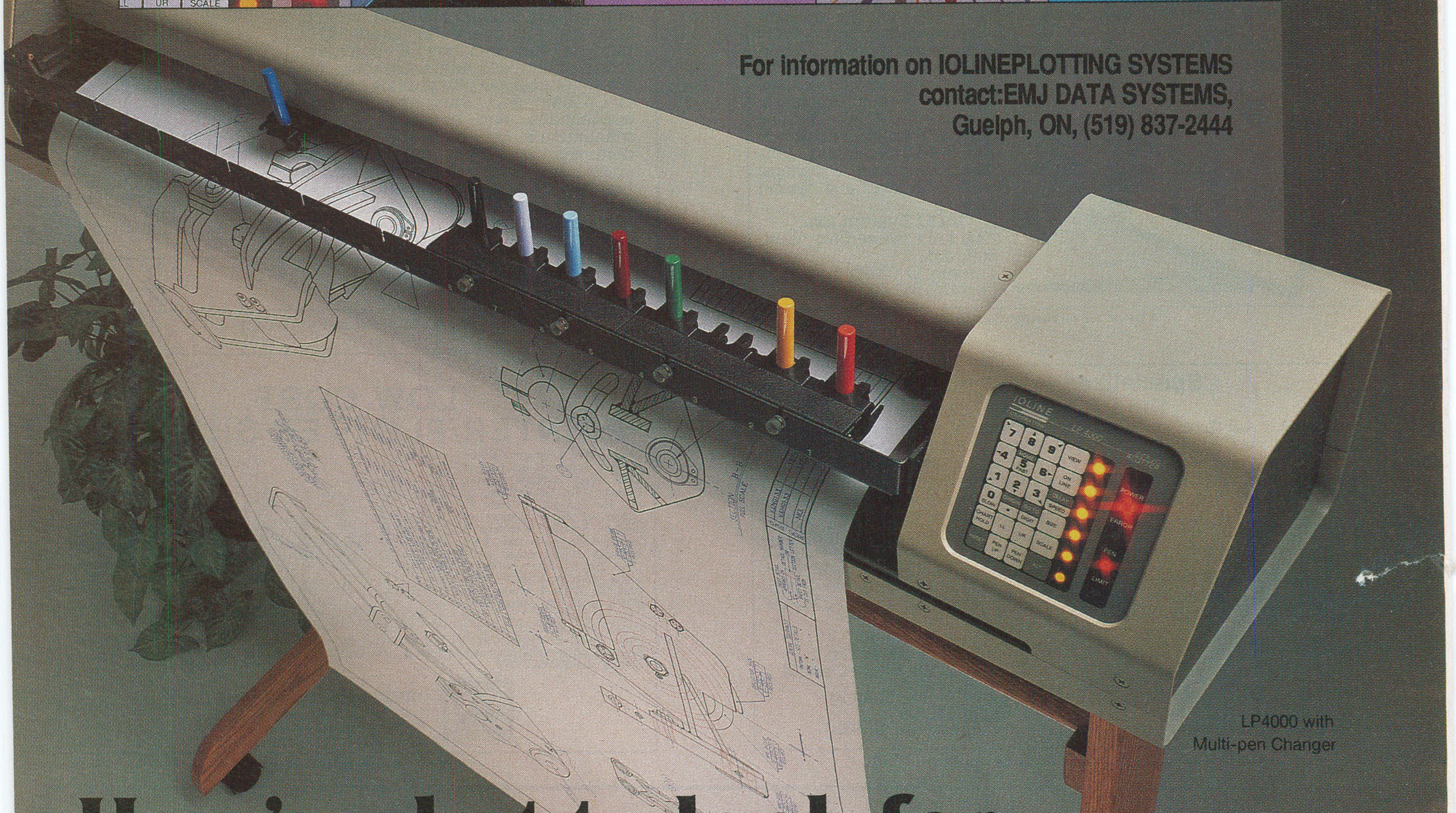

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CAD in Electronic Production

Some examples of what you can do, from project start to printed circuit.

Bill Markwick

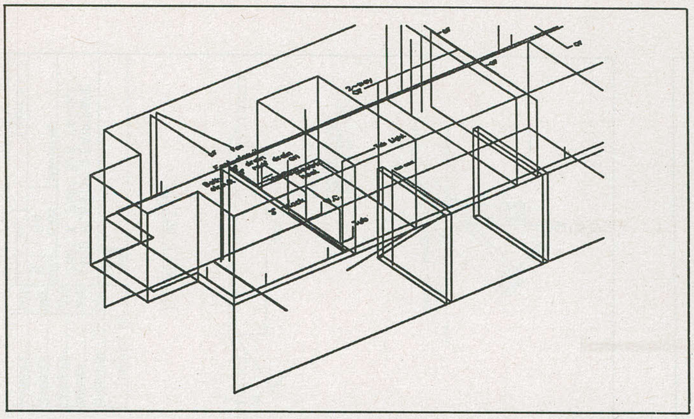


Figure 6. In addition to various viewpoints, the architect can produce working drawings for the various trades. Above is a wireframe of plumbing, heating and wiring requirements.

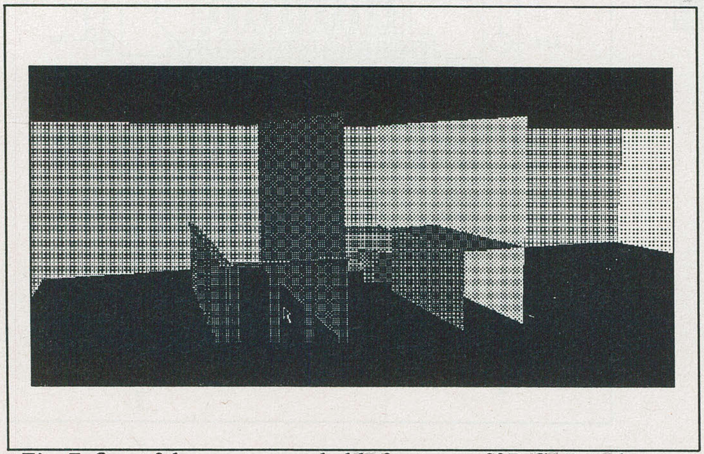


Fig. 7. One of the most remarkable features of 3D CAD is the ability to change a wireframe drawing into a shaded rendering. The above, done with AutoCAD and AutoShade, is only one of thousands of possible viewpoints; in fact, the various views of the interior of a house can be assembled into a sort of slide show, called a "walkthrough". This lets the client see the various visual effects as never before.

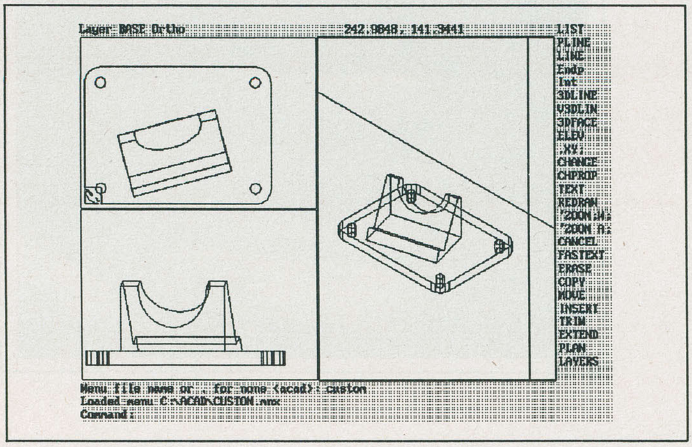
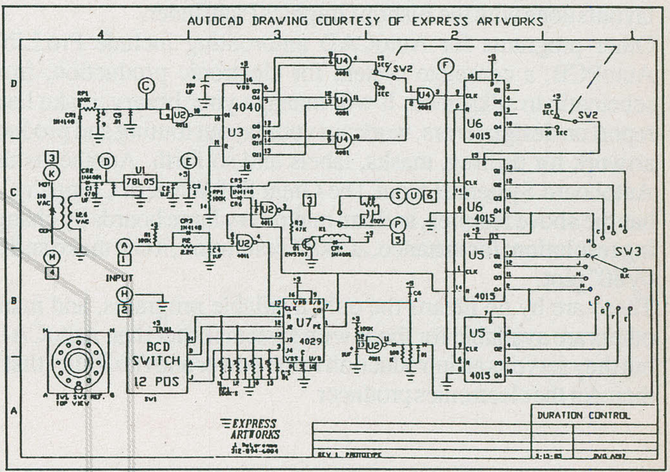


Fig. 8. 3D CAD desktop systems allow the industrial designer, toolmaker, etc., to see products in their final form long before any actual modelling needs to be done. The viewpoints, which can be generated from any angle, allow the designer to see and make changes with a freedom never before available without incredibly expensive mainframe computers.

Once you decide on a circuit design, the traditional method of turning it into a product has been to draw a formal schematic, type up a parts list, make a working drawing of the assembly, sketch out a printed circuit, and then use various types of graphics aids to produce a PCB master. All of this obviously takes a great deal of time, and revisions almost always mean lengthy redrawing. CAD can come to the rescue.

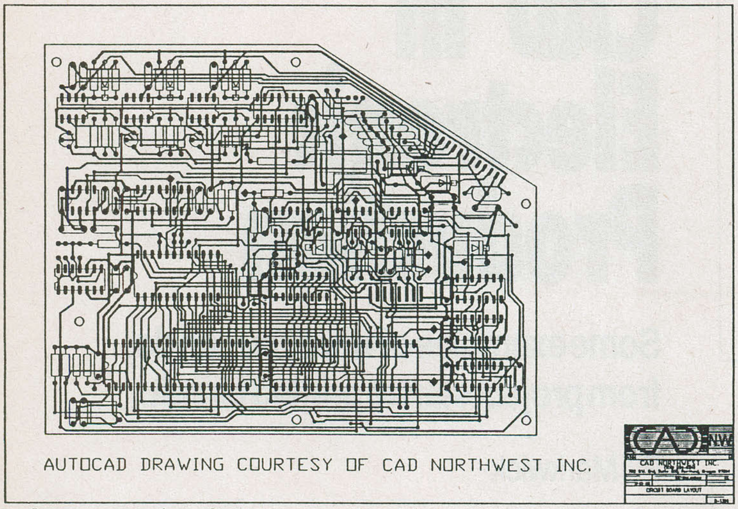
First, CAD's ability to store and manipulate sections of the drawing means that you can produce a schematic very rapidly by loading in entities from your library of electronic symbols. Next, some CAD software (such as AutoCAD) can keep a list of the



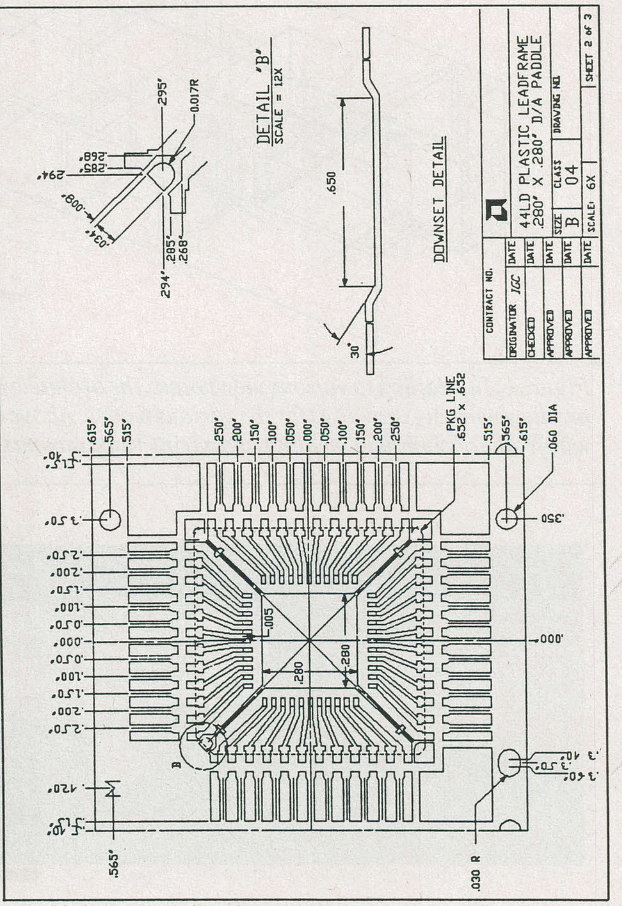
labels that you put on each schematic component; this list can be manipulated by third-party software or your own to produce parts lists, costing lists, and more.

Next, you can use CAD's drawing facilities to produce any type of assembly drawings: plan views, 3D views, exploded or magnified views, or whatever you need for the production line (see the accompanying article on 3D for some of the things you can do).

CAD software can be used to make printed circuit board layouts, although off-the-shelf CAD is limited to drawing lines and pads — you have to figure out how it should fit. Fortunately, AutoCAD contains its own programming language (AutoLisp).



Some examples of printouts made with AutoCAD using the Pathfinder software: a schematic at the top, an autorouted PCB layout at the bottom, and at the end of the article, a connector layout.



We'll leave the peculiarities of this language for another article, and just say that it's the ideal interface to allow third-party software to take control of AutoCAD and work out all the details for you. For instance, the program Pathfinder from Bishop Graphics provides all the features mentioned above: schematic creation, parts lists, unlimited layers for your PCB layout, silkscreen labeling master, top or bottom views, etc. In addition, the optional AutoRouter figures out the PCB layout for you automatically. The three illustrations are printouts of actual layouts done with the Bishop Graphics Pathfinder.

Other programs for AutoCAD autorouting include Pro.Lib's AutoPCB, a complete system for electronic production, from schematic to silkscreen. It will manage your library, make lists, report on design errors, work out your layout routing and produce artwork for drilling, masks, labels and so forth. Another is the Autoboard System II from The Great SoftWestern Company. It has the above features, and can make very large boards by changing resolution; for instance, at .005" resolution, it can make an 80" by 80" plot.

These are by no means the only available programs, and many others are available for those with systems other than AutoCAD, but they serve as an introduction to the power and flexibility that's there for the electronics producer.

Special thanks to Pathtrace Canada, a division of Tor CAD/CAM Corporation, who supplied the illustrations for our brief introduction. They also supply the software mentioned, and you can contact them at 160 Applewood Crescent, Concord, Ontario L4K 4H2, (416) 660-3262, Fax 660-1382.

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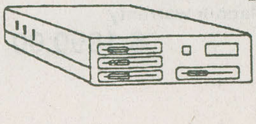

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- Choice of 1.2 Meg 5.25" floppy or 1.44 Meg 3.5" floppy drive
- Dual FDD/HDD Controller, 1:1 Interleave
- AT Case w/ 230W CSA power supply
- Enhanced 101 Key Tactile keyboard
- Serial, Parallel, Clock-Calendar Ports
- 80387 Math Co-processor socket
- Norton SI 4.5 rating - 20
- Landmark Speed Test - 21.5 MHz
- One year parts/labour warranty

$ 2050.00

Custom 386 /25 - Cache

- 80386 processor, 8 / 25 Mhz
- 32K high speed cache ram , 89% hit rate
- 1 Meg to 8 Meg Memory capacity
- 1 Meg installed, 0 wait state operation
- Choice of 1.2 Meg 5.25" or 1.44 Meg 3.5"
- Dual FDD/HDD Controller, 1:1 Interleave
- AT Case w/ 230W CSA power supply
- Enhanced 101 Key Tactile keyboard
- Serial, Parallel, Clock-Calendar Ports
- 80387 Math Co-processor socket
- Norton SI 4.0 rating - 30
- Landmark Speed Test - 41 MHz
- One year parts/labour warranty

$ 2910.00

Leasing available! Rent to own plans! Call for details!

Magus 386 25 Mhz

- 80386 processor, 25 MHz
- 1/2/4/8 Meg Memory capacity on 32 bit memory board
- 1 Meg installed, 0 wait state operation
- Two 32 bit slots
- Choice of 1.2 Meg 5.25 " floppy or 1.44 Meg 3.5" floppy drive
- Dual FDD/HDD Controller, 1:1 Interleave
- AT Case w/ 230W CSA power supply
- Enhanced 101 Key Tactile keyboard
- Serial, Parallel, Clock-Calendar Ports
- 80387 Math Co-processor socket
- One year parts/labour warranty

$ 2350.00

Magus 386/25 Cache

- 80386 processor, 25 Mhz
- 32K High Speed Cache Ram, 89% hit rate
- 1 to 4 Meg Memory capacity on motherboard
- 1 Meg installed, 0 wait state operation
- One 32 Bit Slot, Up to 10 Megs on system
- Choice of 1.2 Meg 5.25" floppy or 1.44 Meg 3.5" floppy drive
- Dual FDD/HDD Controller, 1:1 Interleave
- AT Case w/ 230W CSA power supply
- Enhanced 101 Key Tactile keyboard
- Serial, Parallel, Clock-Calendar Ports
- 80387 Math Co-processor socket
- Norton SI 4.5 rating - 21.1
- Landmark Speed Test - 21.2 MHz
- One year parts/labour warranty

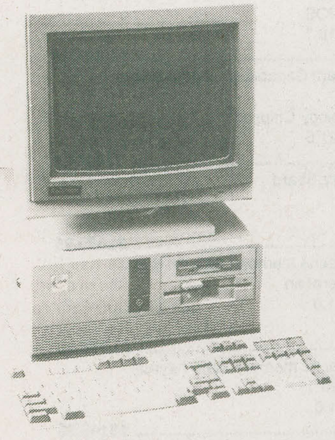
$ 3230.00

Magus 386 /33 - Cache

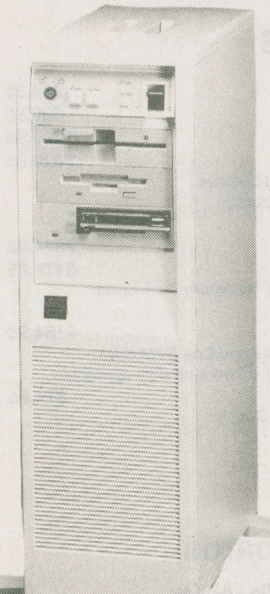
- 80386 processor, 33 Mhz
- 32K high speed cache ram , 89% hit rate
- 1 Meg to 16 Meg Memory capacity
- 16 Meg ram requires optional ram card
- 1 Meg installed, 0 wait state operation
- Two 32 Bit Slots
- Choice of 1.2 Meg 5.25" or 1.44 Meg 3.5"
- Dual FDD/HDD Controller, 1:1 Interleave
- AT Case w/ 230W CSA power supply
- Enhanced 101 Key Tactile keyboard
- Serial, Parallel, Clock-Calendar Ports
- 80387 Math Co-processor socket
- One year parts/labour warranty

$ 4055.00

Detailed, customized, itemized quotations available in store or by fax ! Prices change . Stay Up-to-date.



Mini AT Case



Tower Case

Base Systems Include Full Size AT Case

Change to Mini AT Case .... less $40.00
Change to Tower Case .... add $105.00

Specially Priced Video Options for Systems:

MGA Video Adapter and Amber TTL 12" Monitor $190.00
GVC 8 Bit VGA/256K Card and Goldstar 12" Monochrome Analog Monitor $415.00
GVC 8 Bit VGA/256K Card and Memorex 14" Color Analog Monitor
.41 dp, 640 x 480/16 color 320 x 200/256 colors $640.00
GVC 16 Bit VGA/256K Card and Memorex 14" Color Analog Monitor
.41 dp, 640 x 480/16 color 320 x 200/256 colors $685.00
GVC 16 Bit VGA Card w/512K and Delta Multi-Synch Monitor
.31 dp, 640 x 480/16 colors to 800 x 600/256 colors $930.00
ATI VGAWonder w/256K(no mouse) and NEC 2A
.31 dp, 640 x 480/16 colors to 800 x 600/16 colors $1105.00
ATI VGAWonder w/256K(no mouse) and NEC 3D
.28 dp, 640 x 480/16 colors, 800 x 600/16 colors,1024 x 768/16 colors (interlaced) $1320.00
ATI VGAWonder w/256K(no mouse) and AAMAZING Ultra VGA .28
.28 dp, 640 x 480/16 colors, 800 x 600/16 colors, 1024 x 768/16 colors (interlaced)
automatic vertical sizing in different modes, tilt swivel base $1095.00

Specially Priced Hard Drive Options for Systems

20 Meg 28ms MFM Hdisk, ST125 Seagate and 1:1 MFM HDD/FDD Controller $380.00
40 Meg 28ms MFM Hdisk, ST251-1 Seagate and 1:1 MFM HDD/FDD Controller $515.00
40 Meg 28ms MFM Hdisk, 3053 MiniScribe and 1:1 MFM HDD/FDD Controller $565.00
72 Meg 28 ms MFM Hdisk, 1335 Micropolis and 1:1 MFM HDD/FDD Controller $900.00
40 Meg 40ms RLL Hdisk, 8450 Miniscribe and 1:1 RLL HDD/FDD Controller $435.00
63 Meg 28ms RLL Hdisk, ST277 Seagate and 1:1 RLL HDD/FDD Controller $565.00
104 Meg 28ms RLL Hdisk, 1335 Micropolis and 1:1 RLL Controller $935.00
150 Meg 24ms ESDI Hdsik, 3180E Miniscribe and 1:1 ESDI HDD/FDD Controller $1815.00
330 Meg 24ms ESDI Hdisk, 9380E Miniscribe and 1:1 ESDI HDD/FDD Controller $2340.00
Dual 330 Meg (660 Meg total) ESDI Hdsik, 9380EMiniscribe and 1:1 ESDI HDD/FDD Controller
for Large/Mirrored Servers $4500.00

Second Floppy Options:

Add 360K 5.25" as 2nd Floppy $95.00
Add 1.2 Meg 5.25" as 2nd Floppy $120.00
Add 1.4 Meg 3.5" as 2nd Floppy $135.00

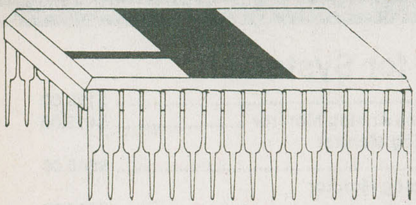
All Systems carry a complete 1 year parts and labor carry in warranty. Technicians are on staff to provide you with informed answers and fast service.

Memory Upgrade Options

1 Meg 256K 100ns Dram $158.00
1 Meg 256K 80ns Dram $225.00
1 Meg 1024K 100ns Dram $148.00
1 Meg 1024K 80ns Dram $175.00
1 Meg 256K x 9 80 ns Simm $260.00
1 Meg x 9 80ns $200.00

System Configuration Form:

	Description:	Price
Base System Price:		
Case Option:		
2nd Floppy Option:		
Video Option:		
Hdisk Option:		
Memory Upgrade:		
MS-DOS 3.3:		
MS-DOS 4:		
Option #1:		
Option #2:		
Total System Price:		



Ram & Math Chips

64k	-150ns Dram	$1.50
64k	-120ns Dram	$2.75
64k	-100ns Dram	$3.15
4x64K	-100ns Dram	$10.80
4x64K	- 80ns Dram	$11.25
256k	-150ns Dram	$4.25
256k	-120ns Dram	$4.50
256k	-100ns Dram	$5.00
256k	-80ns Dram	$7.00
4x256k	-100ns Dram	$18.55
4x256k	-80ns Dram	$20.95
1024k	-100ns Dram	$17.55
1024k	-80ns Dram	$20.95
1024K	-100ns Simm	$175.00
1024K	-80ns Simm	$210.00
256K	-100ns Simm	$70.00
256K	-80ns Simm	$81.00
8087	-5Mhz	$174.95
8087	-8Mhz	$254.95
8087	-10Mhz	$334.95
80287	-6Mhz	$279.95
80287	-8Mhz	$384.95
80287	-10Mhz	$424.95
80387	-20Mhz	$644.95
80387	-25Mhz	$724.95
80387SX-16Mhz		$545.95

Prices subject to change without notice. The trend in prices is down so call for the lastest, most up-to-date pricing.

Power Supplies

XT 150W CSA	$94.95
XT 180W CSA	$104.95
XT 230W CSA	$164.95
Mini AT 180W CSA	$84.00
AT Mini 180W CSA	$104.95
AT Mini 200W CSA	$119.95
AT 200W CSA	$129.95
AT 220 W CSA	$129.95
AT 230W CSA	$164.95
AT 230W Tower CSA	$169.95
Apple Power Supply	$49.95

Surplus Power Supplies

Northern Telecom - 5/12/-5/-12	$18.95
Bouroughs - 5/12	$24.95

Rendition II

Intellegent Graphics Processor $2099.95

The Rendition II is a high-performance 1024x768 256-color intellegent graphics controller for CAD and other graphics intensive PC Applications. On-board TExas Instruments 50 Mhz TMS340101 Graphics System Processor: 6 Mips,32 bit Maximun config. 1 MB dual-ported video ram and 512K dynamic ram Ideal for professional ACAD, PAgemaker, and Ventura power users. Drivers included. 512K video ram installed

8088 / 286 / 386SX / 386 Motherboards

8088 Turbo 10Mhz XT Motherboard $124.95
- ·10 Mhz Turbo, Zero K ram
- ·Legal Bios

Bullet-286e XT Replacement Motherboard $249.95
- ·See ad this page
- ·Norton SI= 8.0
- ·Zero K ram installed
- ·Landmark CPU= 8.7 Mhz

286 12Mhz AT Motherboard $349.95
- ·512K to 4M of Ram capable on board
- ·Six 16-bit slots and Two 8-bit slots
- ·Novell Compatible
- ·Extended memory only, 80287 Socket
- ·Clock Calander on board
- ·Zero K ram installed

286 12Mhz and 16 Mhz "NEAT" Chipset AT Motherboards

· 12Mhz "Neat" Chipset and CPU $499.95

· 16Mhz "NEAT" Chipset and CPU $599.95
- ·up to 8 Megs on Motherboard
- ·16 Mhz CPU
- ·Standard/Neat Enhanced Setup in BIOS
- ·Norton SI= 12Mhz/15.4, 20Mhz/21
- ·Extended and EMS 4.0 Compatible, w/ EMS driver
- ·Zero wait state operation, Zero K ram installed
- ·Novell and OS/2 Compatible
- ·Landmark CPU=12Mhz/13, 20Mhz25.4

386-SX 16Mhz Motherboard $799.95
- ·32 Bit processing on a 16 bit bus
- ·8 Megs of memory capable on board
- ·Novell, OS/2 compatible
- ·Norton SI= 15.9
- ·Socket for 80387SX chip
- ·ZeroK ram on board
- ·CMOS Setup in BIOS
- ·Landmark CPU= 16.1

386 20Mhz Motherboard $1,394.95
- ·20Mhz CPU, Zero wait state operation
- ·Opt.l 8 Meg memory board avail
- ·Novell and OS/2 compatible
- ·Norton SI= 21.2
- ·8 Megs of Simm ram Capable on motherboard
- ·Socket for 80387
- ·Chips and Technology Chipset
- ·Landmark CPU= 21.5

386 25 Mhz Magus no Cache $1549.95
- ·25 Mhz CPU , zero wait state
- ·Two 32 bit Slots
- ·Novell and OS/2 Compatible
- ·with 8 Meg Memory Board
- ·Socket for 80387

386-Cache 25Mhz Magus $2599.95
- ·25Mhz CPU with 1 Meg Ram Installed
- ·4 Megs of memory capable onboard
- ·Up to 10 Megs with opt. memory board
- ·Norton SI =30
- ·32K High speed cache memory, 89% hit rate
- ·Zero wait state operation
- ·Landmark CPU=41.0
- ·One 32 bit slot

386-Cache 25Mhz Motherboard $2,395.95
- ·25 Mhz CPU, O wait state operation
- ·with 8 Megs of memory board
- ·Norton SI=30
- ·32K High speed cache memory, 89% hit rate
- ·Zero K ram installed
- ·Landmark CPU=41.0

386 - Cache 33Mhz Magus Motherboard $3149.95
- ·33 Mhz CPU , 0 wait state
- ·with 8 Meg Meory Board
- ·32K High speed cache memory, 89% hit rate
- ·Two 32 Bit slots, upto 16 Megs of memory

Cases and Power Supplies

XT Case with AT Style — $64.95

AT Full Size — $99.95

AT Full Size w/230W CSA Power Supply — $239.95

AT Hosteh Tower Case — $229.95
- ·"The Nicest Tower Case in the World"
- ·Turbo,Rest Switch, Keyboard Lock, 3 Leds
- ·Both sides of case removable for easy access
- · Fits 6 Half Height Devices
- · Reinforced construction
- · 25" x 17" x 7.5"

AT Hosteh Tower Case w/230W Power Supply — $344.95

MINI AT "Small Foot Print" with 180W Power Supply — $179.95
- ·Ergonomic Desktop Unit, super unit
- ·Holds full size AT Motherbaord, use all slots
- ·Fits Two half height floppies, One Half Height Hdisk, 2 3.5" Hdisks

PS/2 Style Loyalty Case with 150W Power Supply — $164.95
- ·Low and sleek design
- · Use standard XT,AT,386 Motherboard
- ·Fits Two 3.5" drives and One 5.25" drive
- ·Two 16-bit slots and Two 8-bit slots available

External Hard Drive Case with internal power supply — $74.95
- · Holds Two half height drives
- ·80 W CSA Power Supply

AWARD BIOS

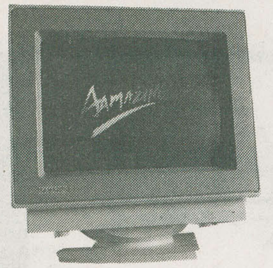
AWARD SOFTWARE, INC. HIGH PERFORMANCE BIOS AND SYSTEM SOFTWARE

Award XT Bios	$29.95
Award AT Bios	$49.95
Award AT "Neat " Bios	$49.95
Award 386 Bios	$59.95
Award Keyboard Bios	$49.95

Custom BIOS products available, custom hdrive tables available. Award BIOS products are NOVELL compatible.

Keyboards

5060 Tactile - 84 Key	$74.95
5061 Tactile -101 Key	$84.95
Keytronics RT 101 -101 Key	$94.95
Keytronics Enhanced Professionall Keyboard	$169.95



Monitors

Hi-Res TTL 12" Monitor ... $129.95
·Monochrome graphics compatible
·Available in Amber and Paper White
Goldstar 12" Paper White VGA Analog Mono Monitor ... $224.95
·640x480
·.31 dot pitch
Packard Bell EGA Monitor 13" Monitor .31 Dot Pitch ... $509.95
·640x350
·16 colors
NEC 2A Analog Super VGA 14" Monitor .31 Dot Pitch ... $799.95
·640x480 and 800x600
·256 colors out of 1/4 million
NEC Multi-Synch 3D 14" Monitor .28 Dot Pitch ... $999.95
·640x480, 800x600, 1024x768
·256 colors out of 1/4 million
Tatung 1296 12" Analog Monitor .28 Dot Pitch ... $564.95
·640x480
·256 colors out of 1/4 million
Tatung 1496 14" Analog Monitor .31 Dot Pitch ... $594.95
·640x480
·256 colors out of 1/4 million
Memorex VGA 14" Analog Monitor .41 Dot Pitch ... $464.95
·640x480
·256 colors out of 1/4 million
Delta Multi-Synch 14" Monitor .31 Dot Pitch ... $674.95
·640x480, 800x600
·256 colors out of 1/4 million
Goldstar Full Page DTP Monitor ... $1749.95
·1024x768
·High speed video board included
·Drivers for popular software
·Hercules compatible mode

ATi® TECHNOLOGIES INC.
Technology you can Trust.

Video Cards

CGA ... $74.95

MGA/CGA Adapter ... $89.95
MGA w/ printer port ... $74.95

EGA Generic 640x350 ... $194.95

GVC 8 Bit VGA Card ... $224.95
·8 bit bus
·256k video ram
GVC 16 Bit VGA Card ... $264.95
·16 bit bus
·256k video ram, upgradable to 512K

ATI Graphics Solution ... $99.95
ATI VGAWonder
·w/ 256K Video Ram /no mouse ... $354.95
ATI VGAWonder
·w/ 512K Video Ram /no mouse ... $419.95

Paradise VGA PLUS ... $264.95
Paradise VGA PLUS 16 ... $399.95
Paradise VGA Professional ... $464.95

Ultra VGA Special

AAmazing Ultra VGA Monitor w/ATI VGAWonder
·VGA, Super VGA and Ultra VGA (1024 x 768)
·Automatic Sizing of picture for different Video Modes
·With ATI VGAWonder Card
·256K Video Ram, no mouse

$1095.00

Drive Control Cards

WD-3V - MM2 HDD/FDD AT MFM Controller ... $189.95
WD-6U - MM2 1:1 MFM AT Ctrl ... $244.95
WD E044 MFM AT Ctrl ... $234.95
WD RA-2 HDD/FDD AT RLL Controller ... $224.95

DTC HDD/FDD AT MFM 1:1 Controller 7280 ... $244.95
DTC HDD/FDD AT MFM 2:1 Controller 5280 ... $189.95
DTC HDD/FDD AT RLL 1:1 Controller 7287 ... $274.95
DTC HDD/FDD AT ESDI 1:1 Controller 6280 ... $369.95

Adaptec 2372 HDD/FDD AT RLL 1:1 Controller ... $299.95
Adaptec 2322 HDD/FDD AT ESDI 1:1 Controller ... $365.95

XT -Four Floppy Drive Controller ... $44.95
XT/AT -Two HD Floppy Drive Controller ... $79.95
XT Multi I/O
-FD Ctl,Ser,Par. Opt 2nd Ser,Clk/Cal,Game ... $79.95
XT High Density/Multi I/O
-FDD Ctl,Ser,Par. Opt 2nd Ser,Clk/Cal,Game ... $99.95

XT Hdisk MFM Controller ... $84.95
XT Hdisk RLL Controller ... $94.95

Input / Output Cards

AT I/O - Ser,Par, Opt. 2nd Ser. ... $69.95
XT I/O - Ser,Par. Opt 2nd Ser,Clk/Cal,Game ... $74.95
AT - 2Ser. Port (16450,1488,1489,Cable) ... $39.95
XT - 2Ser. Port (8250,1488,1489,Cable) ... $24.95

8250 - XT Uart ... $12.95
16450 - AT Uart ... $16.95

Everex 170A AT I/O ... $99.95
Everex 170B AT I/O ... $109.95

XT Parallel Card ... $34.95
XT Serial Card ... $39.95
XT Serial/Clock Calander Card ... $54.95
XT-Game Card ... $34.95
Gravis AT Game Controller ... $49.95
Gravis Joystick Y Cable ... $19.95
Quickshot Dual Port Game Controller ... $19.95

Modems & Fax Cards

GVC Modems

GVC 1200 Internal ... $89.95
GVC 1200 External ... $109.95
GVC 2400 Internal ... $144.95
GVC 2400 External ... $179.95
GVC 1200 Mini Modem ... $139.95
GVC 2400 MNP Ext. ... $269.95

Ven Tel 1200 Internal ... $49.95

Asher Fax Cards

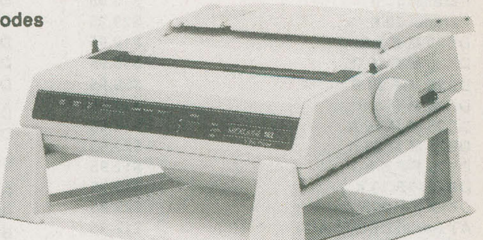
4800 Baud Internal ... $374.95
9600 Baud Internal
w/1200B Modem Included ... $899.95

Intel Fax Card

Intel Communication Co-Processor
9600 Baud Fax ... $1350.00

Mice & Joysticks

Logitech C9 Serial ... $94.95
Logitech C9 Bus ... $99.95
Logitech PS/2 Hi-Res ... $134.95
Mouse Pad ... $9.95
Gravis Joystick ... $44.95
Quickshot Joystick ... $19.95

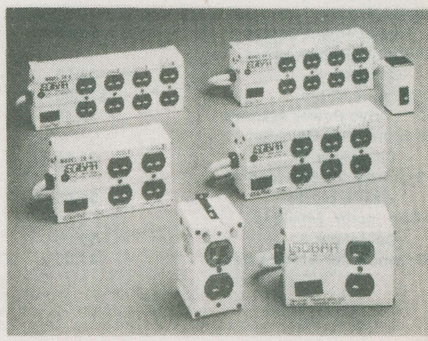


Okidata Microline 182 Turbo

The affordable. rugged printer for Tough Industrial Workstaion and POS Applications.
·Super Short Tear Capabilities
·Bottom and Rear Feed
·Multi Part Forms without wasting pages
·255 High speed Draft
·Epson Compatible
·Built "Tank Tough" Okifdata Quality

$424.95

TRIPP LITE
"THE POWER PEOPLE"



Isobar

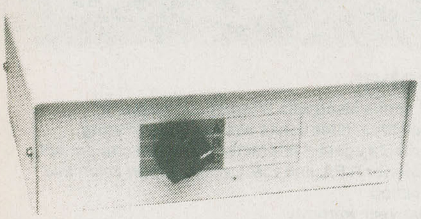
·21 active electronic filtering components
·Individual filter banks with multiple filtering protects against interaction between components
·Superior R.F.I. and E.M.I. noise suppression and rejection
·Two year warranty
Isobar4 - 4 Outlets ... $119.95
Isobar8 - 8 Outlets ... $149.95
Isotel - 4 Outlets with Modem protection ... $179.95

TrippLite Battery Back-up Systems

·Synchronised Transfer (2ms.)
·Built-in spike and noise filtering network
·Audible alarm during power failures
·Complete brownout protection
·Two year warranty
450W ... $675.00
750W ... $1095.00
1200W ... $1545.00

Cables

Parallel 6 ft	$10.95
Parallel 10 ft	$15.95
Parallel 20 ft	$29.95
DB25 M-F 6 ft	$10.95
DB25 M-F 10 ft	$15.95
DB25 M-F 20 ft	$29.95
DB25 M-M 6 ft	$12.95
DB25 M-M 10 ft	$18.95
DB25 M-M 20 ft	$29.95
DB25 F-F 6 ft	$12.95
DB25 F-F 10 ft	$18.95
DB25 F-F 20ft	$29.95
AT Serial DB9-25 6ft	$12.95
AT Serial DB9-25 10ft	$18.95
AT Serial DB9-25 20ft	$29.95
Centronics M-M 6ft	$12.95
Centronics M-M 10ft	$18.95
Centronics M-M 20ft	$29.95
Centronics M-F 6ft	$12.95
Centronics M-F 10ft	$18.95
Centronics M-F 20ft	$29.95
DB9 M-F 6ft - Monitor Ext.	$8.95
DB9 M-F 10ft - Monitor Ext.	$11.95
DB9 M-F 20ft - Monitor Ext.	$14.95
DB15Hd F-M VGA Monitor Ext. Cable 6 ft	$29.95
DB25M - PS/2 8 pin 6 ft	$12.95
DB25M - PS/2 8 pin 10 ft	$18.95
DB9M - PS/2 8 pin 6 ft	$12.95
PS/2 8 pin M-M 6 ft	$12.95
Hard Drive Cable Set	$9.95
Dual Hard Drive Cable Set	$11.95
Floppy Drive Cable Set	$6.95
Keyboard Extension 6 ft	$7.95
Computer AC Cable	$4.95
Standard AC to Computer Power Supply Cable	$7.95
RCA Video Cable	$1.00
DB9-25 M-M 10 Ft.	$10.95
MIDI Cables	$12.95
Y Cables for Drives	$3.95
Power Supply Replacement Cables	$4.95
Keyboard Replacement Cables	$7.95
DB37 M-M Cable	$12.95
3.5 " Drive Power Adapter	$1.49
25 Conductor Shielded Cable per ft.	$1.45
15 Conductor Shielded Cable per ft.	$1.05
9 Conductor Shielded Cable per ft.	$0.95
60 Conductor Ribbon Cable	$1.80

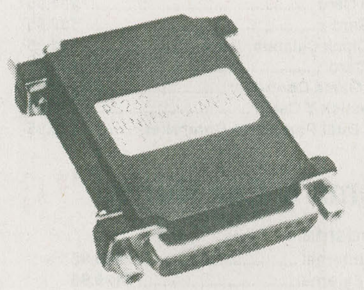


Switch Boxs

2 Way Serial	$39.95
3 Way Serial	$44.95
4 Way Serial	$49.95
2 Way Parallel	$39.95
3 Way Parallel	$44.95
4 Way Parallel	$49.95
2 Way Crossover Parallel	$44.95
2 Way Crossover Serial	$44.95
Serial-Parallel Converter	$94.95
Parallel-Serial Converter	$94.95

Accessories

DS 40 3.5 Diskette Box	$9.95
DS 50 5.25 Diskette Box	4.95
DS 70 5.25 Diskette Box	5.95
DS 80 3.5 Diskette Box	$11.95
DS 50 5.25 Diskette Box	$10.95
DS 100 5.25 Diskette Box	$12.95
Diskette Mailer Plastic 5.25	$3.00
Diskette Mailer Plastic 3.5	$3.00
Stablient 22	$39.95
Ribbons for:	
Roland 1011,1012,1112,1250,1215	
Black	$14.95
Red	$14.95
Blue	$14.95
Roland 9 Pin Raven	
Black	$14.95
Ribbons for Roland 24 Pin Raven	
Black	$14.95
Roland 2450	
Black	$21.95
Star NX1000 Ribbons	
Black	$12.95
8.5x11" Paper , 40M Fine Edge	
500 pcs	$11.95
3000 pcs	$62.00
8.5x14" Paper	
3000 pcs	$64.95
Computer Lables , 4 x 1 7/16	
500 pcs	$9.95
1000 pcs	$18.95
Universal Printer Stands	$14.95
Mouse Pads (Foam)	$9.95
Copy Clips	$7.95
Plastic CPU Stands	$19.95
Steel CPU Stands	$29.95



RS-232 Adapters

DB25 M-M Gender Bender	$7.95
DB25 F-F Gender Bender	$7.95
DB15 M-M Gender Bender	$7.95
DB15 F-F Gender bender	$7.95
DB9 M-M Gender bender	$8.95
DB9 F-F Gender bender	$8.95
Centronics M-M Gender Bender	$7.95
Centronics F-F Gender bender	$7.95
Centronics -Rs-232 Adptr	$7.95
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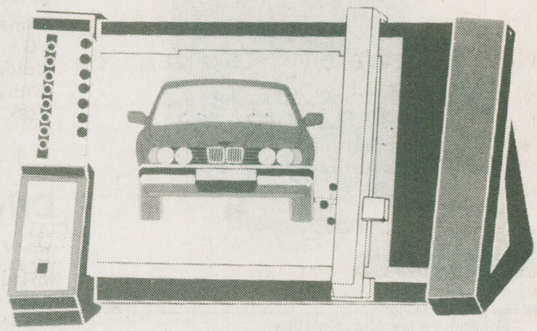

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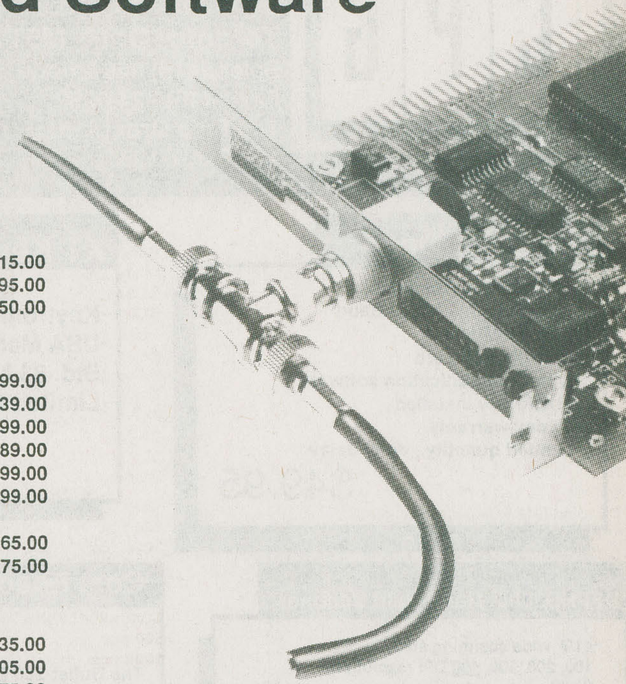

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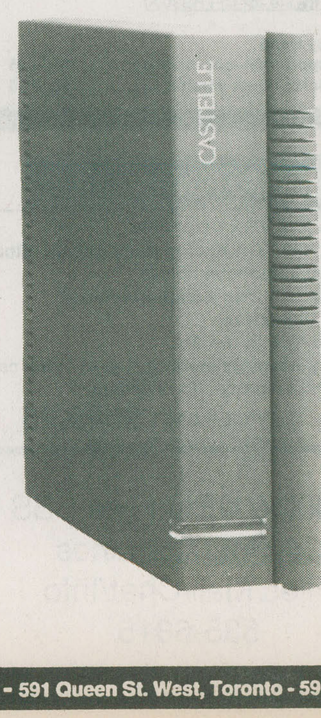

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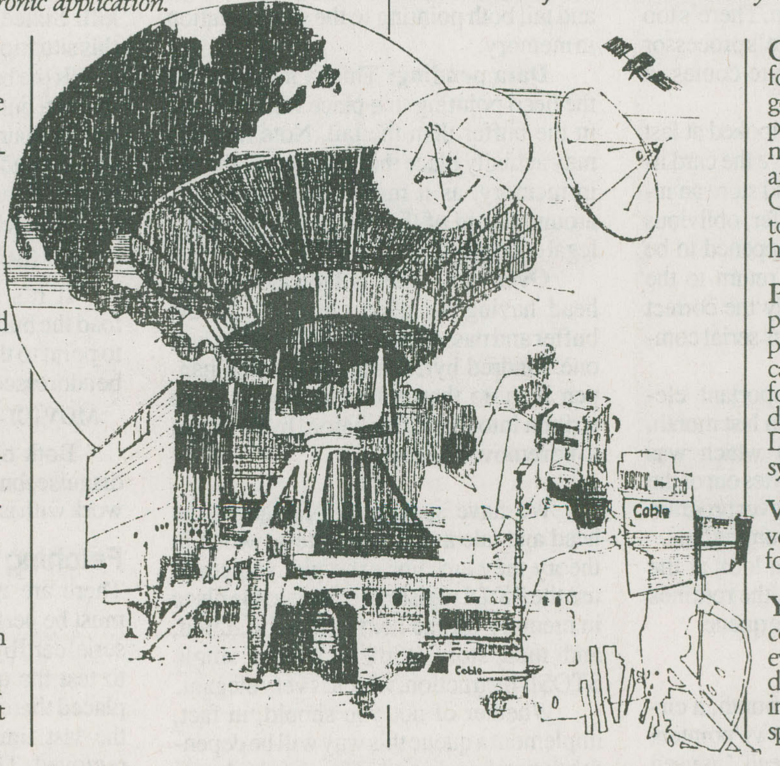

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PC Hardware Interfacing Part 12

This month we'll look at some additional interfacing code for the serial port card, including the actual functions which allow higher level languages to deal with interrupt driven serial data.

STEVE RIMMER

Last month we saw how the serial port hardware could be driven by a background interrupt handler function. While it's possible to deal with it as a foreground task by "polling" it, much as is done with simpler computers like the Apple][+, this is both inefficient of the computer's resources and probably not all that effective a way to deal with the problem even if your program has time to burn. There's too high a chance of your machine's processor not being around when a byte comes in and, as such, losing data.

The driver fragment we looked at last month illustrated a way to have the card itself call a routine which would store an incoming byte in a circular buffer, oblivious to whatever the computer happened to be doing at the time, and then return to the foreground task. This is really the correct way to deal with asynchronous serial communication.

There were several important elements left out of the code from last month. One fairly obvious element which was missing was a way to get the bytes out of the circular buffer for use by whatever program is supposed to deal with the incoming data.

This month we'll have a look at the foreground part of the driver, the routines which are called to manage the queue.

Heads or Tails

As you will recall from last month, a circular buffer, or "queue", has two pointers into it. The first pointer, the "head", is used to indicate where the next byte will go when an interrupt is thrown by the serial card. This was pretty well covered in the last installment of this series. The other pointer, the "tail", indicates where the next character to be retrieved from the buffer lies.

After each pointer operation the pointers in question are incremented circularly, that is, they're run through a routine which sets them to the next position in the queue. This will be the next location in memory unless the next location lies beyond the agreed upon end of the buffer, in which case it will be the start of the buffer.

There are several states which a circular queue can be in. They are as follows:

Empty: This is indicated by the head and tail both pointing to the same location in memory.

Data pending: This is indicated by the head pointing to a place further along in the buffer than the tail. Note that this may actually place the head before the tail in memory, as it may have "wrapped" around the ed of the buffer. This is still a legal condition.

Over run: This is indicated by the head having wrapped clear around the buffer and passed the tail. If the buffer was one hundred bytes long, this would happen if more than a hundred bytes were written into the buffer before bytes began to be removed from it.

We have spoken this far about the head and tale as being pointers, which in theory they are. For example, you could use the ES:DI registers to point to the place in memory for the next byte to be stored, and then store it there with a single STOSB instruction, which is very elegant.

Whether of not you should, in fact, implement a queue this way will be dependant upon how big a buffer you think you need. A true pointer on a PC is a thirty-two bit number, and a very awkward quantity to work with at the assembly language level. You will find that you'll have to do a lot of juggling between the DI and ES registers, for example, to see if the pointer has exceeded the end of the buffer.

If you wanted to write a terminal program which used all the otherwise unspoken-for DOS memory for as a huge serial buffer... making the possibility of an over run error condition exceedingly remote... this would be a good way to handle it. On the other hand, if you were writing a modem program in which the maximum chunk of data sent at a time could never exceed a few kilobytes, it amounts to a considerable degree of overkill. Sixteen bit numbers will suffice in this situation with room to spare.

If the buffer is a fixed area in memory, that is a buffer created with the DB directive in your assembly language program, you can address it very easily like this. We'll allow that the position in the buffer being addressed is held in the BX register.

```
MOV [BUFFER+BX],AL
```

If it's an allocated buffer, you can load the buffer segment into ES and set DI to point to the buffer itself. The buffer can be addressed like this.

```
MOV [DI+BX],AL
```

Both of these are really pointers in disguise, but the only number you have to work with is a simple sixteen bit integer.

Fetching Bytes

There are two primary functions which must be performed on the byte queue of a serial card by a foreground task. The first is to test the queue to see if data has been placed there by the interrupt handler since the last time all the previous data was removed. The second is to be able to actually remove data, that is, to fetch bytes from the buffer.

The first function can be handled very simply with the following code. This assumes that we'll be using sixteen bit offsets into the buffer rather than true thirty-two bit pointers.

```
TEST_SERIALPROCNEAR
MOVAX,SERIO_HEAD
```

```
SUBAX,SERIO_TAIL
RET
TEST_SERIALENDP
```

If you call this function and AX is zero, there are no bytes waiting in the buffer. It may seem that this function will return the number of bytes waiting in AX, but this is not actually true. Recall that the buffer is circular. The head pointer can point to memory which lies before the tail pointer in absolute memory locations and still in front of it as far as the buffer is concerned. If this happens... a common occurrence, actually... the number returned in AX will be enormous and quite meaningless.

If this function returns a non-zero value you can retrieve the next byte in the buffer with the following function.

```
SERIO_SIZEEQU500

FETCH_SERIALPROCNEAR
MOVBX,SERIAL_TAIL
MOVAL,[SERIO_BUFFER+BX]
CALLBUMP_POINTER
RET
FETCH_SERIALENDP

BUMP_POINTERPROCNEAR;INCREMENTAPOINTER
PUSHAX
MOVAX,OFFSETSERIO_BUFFER+SERIO_SIZE
INCBX

CMPBX,AX
JGEBUMP_PTR1
POPAX
RET

BUMP_PTR1:MOVBX,OFFSET
SERIO_BUFFER
POPAX
RET
BUMP_POINTERENDP
```

You will notice that this uses the same pointer adjustment routine as turned up in the interrupt handler last month. In a real world driver, it's convenient to actually use the same code, as the head related functions and the tail related functions generally live in the same program. This ensures that both the head and tail pointers will always be treated the same way.

There are a number of other things you might want to be able to do with the buffer. For example, if you wanted to throw away all the data in the buffer you could use this routine.

```
FLUSH_BUFFERPROCNEAR
MOVSERIO_HEAD,0
MOVSERIO_TAIL,0
RET
FLUSH_BUFFERENDP
```

This simply sets both pointers to the start of the buffer again.

Real World Data

In a complex program which wants to interface to a generic serial driver, the author of the driver must often be unaware of what the author of the foreground application will want to do with the serial port. For example, a terminal program which might send over complex screens with lots of ANSI codes and data could well send down eight or ten kilobytes of data without pausing. The foreground task... the terminal program... would expect the serial driver to deal with this without hiccuping and losing some of it. On the other hand, a simple XMODEM program would never encounter more than one hundred and thirty-two bytes of data before the foreground task fetched it from the buffer, chewed on it and then sent the command back up the line for another chunk.

There are a number of useful ways in which the basic driver concept we've been looking at can be enhanced. The first one involves allowing the foreground task to specify the size and location of the buffer. Under the C language, for example, a programmer can *allocate* blocks of memory which are then accessible through pointers. Since the programmer writing the application which will talk to the serial port should know what sort of data is likely to arrive, it makes more sense to have the calling task allocate the buffer and pass a pointer to it to the serial port driver.

This is how the PC BIOS serial handler probably should have worked.

If this is the case, the as yet undiscussed code which initializes the serial card, sets up the interrupts and so on would be passed a pointer to a serial buffer, that is, a segment value and an offset value. Allowing that these will be stored in memory as BUFFER_SEGMENT and BUFFER_OFFSET, you would load bytes into the buffer like this. We'll allow that the value _DATA is the data segment where all the variables get stored for our driver.

```
PUSHAX
MOVAX,_DATA
MOVDS,AX
POPAX
MOVES,BUFFER_SEGMENT
MOVBX,BUFFER_OFFSET
MOVES:[BX],AL
CALLBUMP_POINTER
```

Likewise, you would get a byte from the buffer like this.

```
MOVAX,_DATA
MOVDS,AX
MOVES,BUFFER_SEGMENT
MOVBX,BUFFER_OFFSET
MOVAL,ES:[BX]
CALLBUMP_POINTER
```

This assumes that a record is kept of the original value for BUFFER_OFFSET, such that BUMP_POINTER could restore it when a buffer pointer had to wrap around past the end of the buffer.

The value of SERIO_SIZE would also be passed to the interrupt setup routine, such that the calling code would be able to define the size of the interrupt buffer.

This offers us a different way to look at handling serial data. For example, let's say that we wanted to send a screen of text from one computer to another over a serial link. One way to get this together would be to fetch each byte from the screen, add in some ANSI escape sequences if there were different colours and such and send the data through the port. At the other end, the receiving software would fetch the bytes from the serial port driver's buffer, as we've seen, and print them to the screen. This is very, very slow.

There's a better way. Suppose we were to define the serial data buffer as being the screen buffer itself. We'll tell the serial port driver that this buffer is at least four thousand bytes long. The sending computer would just transmit the raw contents of its screen buffer and the receiving interrupt handler would place it in exactly the right place, thinking that the screen buffer is really its queue.

It would, of course, be essential to flush the buffer after each screen was sent as allowing the head pointer to actually wrap would be messy. Obviously, there is no need to retrieve characters through the tail pointer in this example, as they will already be in their ultimate destination.

The slick part of this approach is that it really doesn't involve any modifications to the serial driver as we've discussed it thus far. It simply makes clever use of the concept of a circular serial queue.

Rubber Biscuit

This driver is still a long way from being complete. We haven't seen how it gets hooked into the hardware of a PC as yet, nor have we really talked about interfacing it to higher level code. The latter subject is one which calls for a bit of forethought and head scratching to come up with a system which is both flexible enough to make the driver worth using and fast enough to improve on the performance of the BIOS and simple polled communications.

We'll continue to wear the problem down next month. ■

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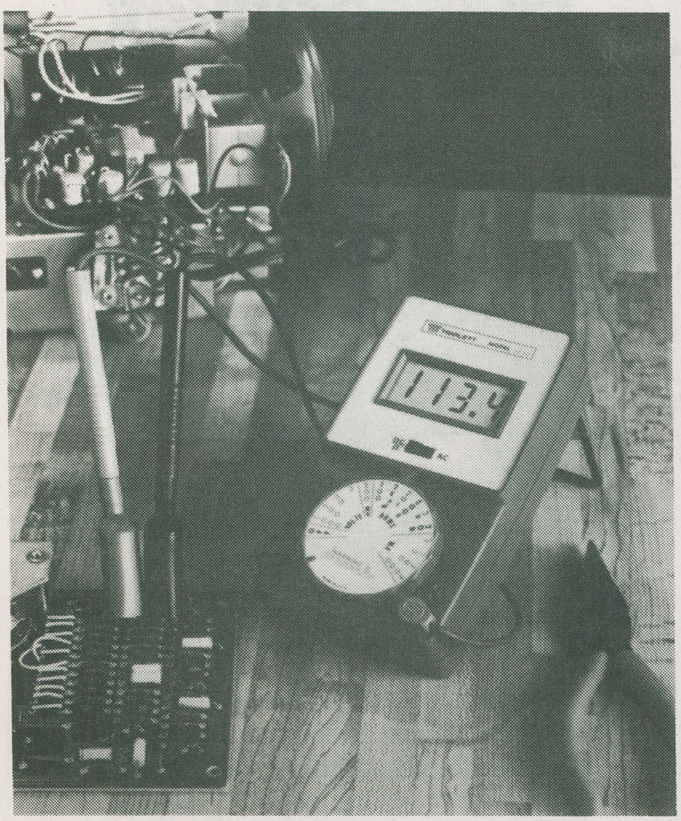

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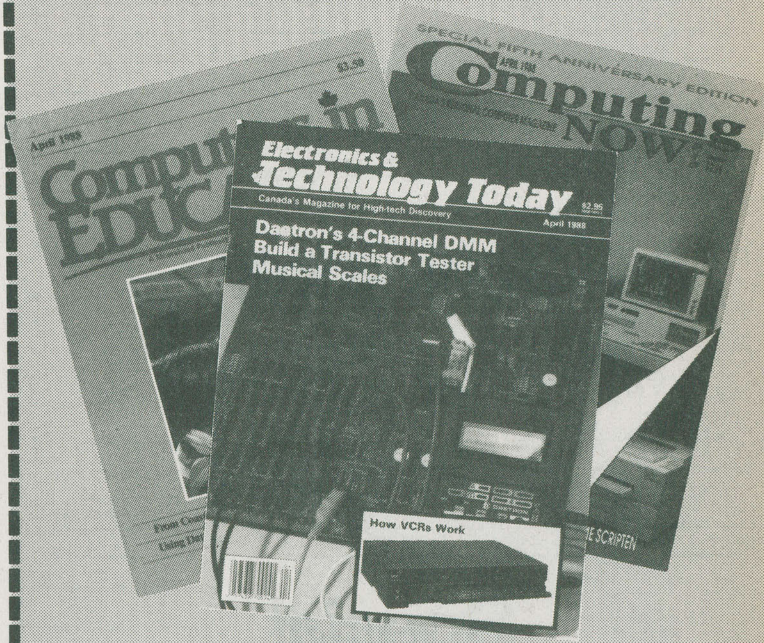

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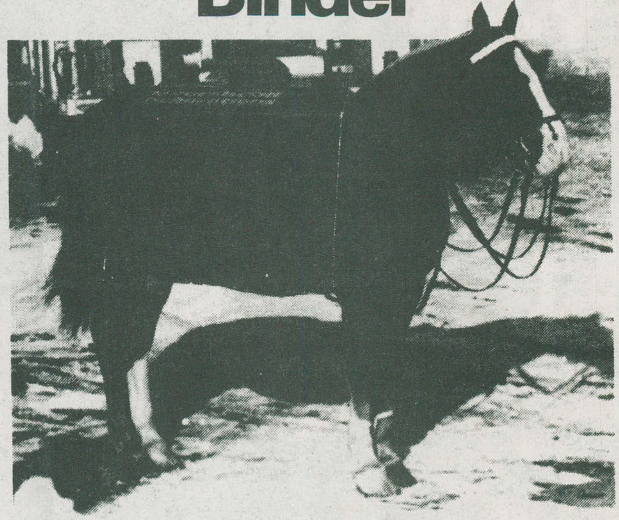

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There are two basic types of seismometer. Portable "velocity type" instruments designed to respond to vertical or transverse waves shorter than two seconds period, and longer period fixed instruments. The most spectacular traces are recorded by long-period instruments which can detect the surface waves arriving from earthquakes anywhere on the planet, so that's what I built.

A seismometer tuned to over six seconds period has the big advantage of discriminating against short wave local disturbances like traffic, while still able to detect the short sharp transients that signify the onset of a distant earthquake.

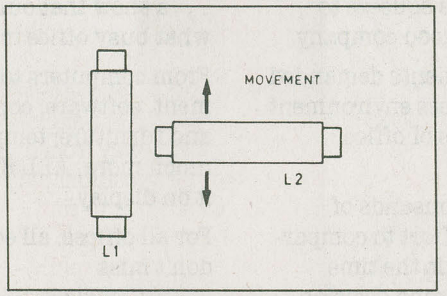


Fig. 1. Coil position and movement.

It was decided to build a "garden gate" type — a horizontal pendulum tuned to an eight second period, with the beam set North/South to be most sensitive to East/West transverse waves. Short period instruments are usually electrodynamic with a moving magnetic mass exciting a fixed coil to convert seismic motion into voltage. As the period increases, this gets more difficult, and involves coils with thousands of turns of fine wire to give adequate signal as well as precision temperature compensated spring suspensions.

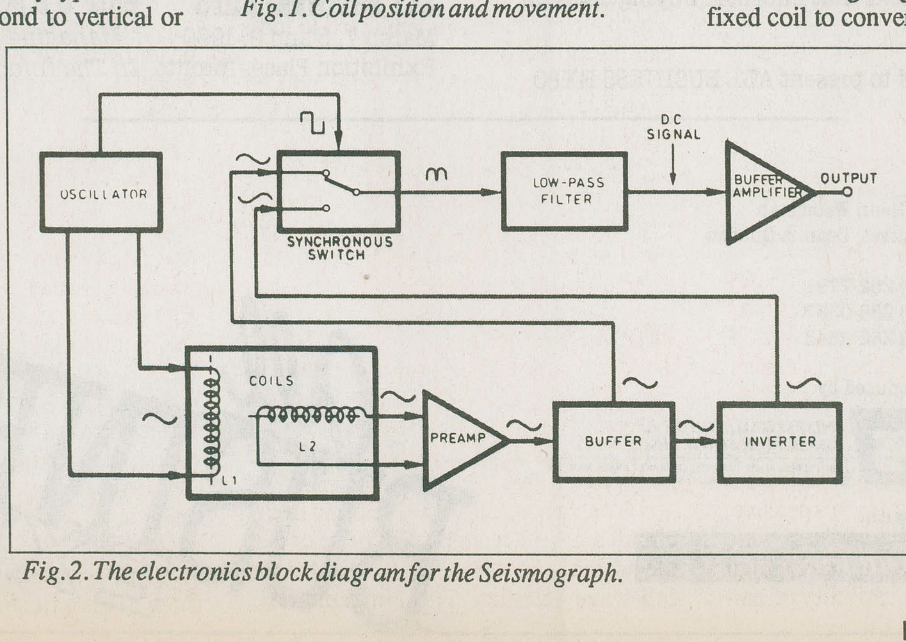


Fig. 2. The electronics block diagram for the Seismograph.

A simpler way is to use electronics to sense the deviation of a long period seismic beam fro its mechanical null — so with the help of Andy Flind, an

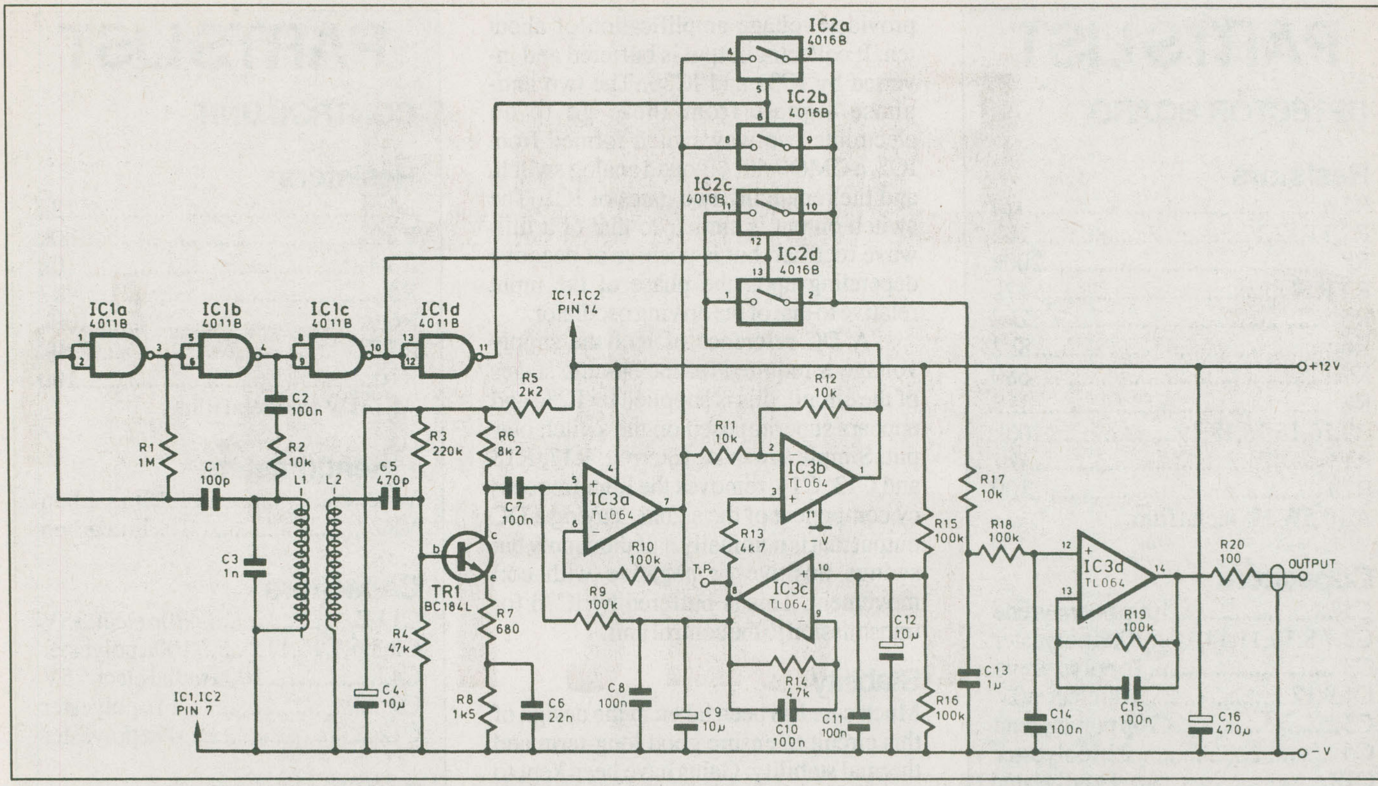


Fig. 3. Circuit diagram for the detector stage of the Seismograph. The coils L1,2 are wound on ferrite rod and are interchangeable.

electronic pickoff system was developed which gave high sensitivity and stability without needing any precision mechanical fitting.

Construction is split between electronics and mechanic (to be described next month) and can be tackled in any order, although some thought should be given to the siting of what is rather a large instrument before final construction is started.

Electronics

The electronics of this project are designed to sense tiny movements of the Seismograph's main beam while imposing practically no friction. As well as being sensitive, the circuit needs good long-term stability, a feature not often required of DIY circuits.

There are various transducers capable of detecting movement. The best known, the variable resistor, is unsuitable because of its high level of friction. Various optical and capacitive sensors, often used in industry, were rejected because they involve electromechanical "follower" mechanisms that would be difficult to make. Linear Hall-effect devices were considered, but they are expensive, their long-term drift characteristics were unclear, and they draw a fairly high operating current. The possibility of battery operation was considered desirable for this project.

The system chosen uses two coils would on short lengths of ferrite rod. One of these is energized with a sinewave current. The other is placed at right-angles about five to ten millimeters away from it, as shown in Fig. 1. If the coil positions are carefully adjusted, it is possible to find a "null" point where induced voltages in the second coil cancel to zero. Small displacements then result in output voltages, which are amplified and detected to indicate the movement.

As a bonus, the phase of the induced output depends on the direction of movement away from null. In one direction it is in phase with the energizing signal, in the other, opposite to it. If a synchronous detector is used, driven by the oscillator, the direction of movement will be indicated by positive or negative output.

Block Diagram

A block diagram of the system is shown in Fig. 2. An oscillator drives one coil and a synchronous electronic switch. The output from the second coil is amplified, buffered and inverted before going to the switch.

The various signal waveforms in the circuit are shown, and it will be seen that the switch output is similar to that from a full-wave rectifier. The remaining AC component in this is removed by passive low-pass filtering, and a DC amplifier and buffer complete the circuit.

While the effect is not completely linear, it is good enough over the range of movement needed. It takes only a small energizing current from a simple oscillator, is extremely sensitive, yet is easy to mount and set up. Careful design of the electronics provides good long-term stability. Additionally, it's cheap and easy to make.

Disadvantages? Well, the coil on the beam needs two wires to energize it, but these, if thin and placed close to the fulcrum, do not impair performance.

Practicalities

An instrument of this type is often sited some distance from occupied buildings to minimize disturbance and vibration from human activities. However, it would be useful to have the output available in the workshop or laboratory. With this in mind, the circuit is split into two sections, a "Detector" board for the Seismometer itself, and a "Control" unit, containing the power supply and output processing circuitry.

Connections between the two units consist of a single-ended low voltage supply, and one low-impedance signal lead that uses the negative supply as "common". This arrangement means that con-

PARTS LIST

DETECTOR BOARD

Resistors

R1 .... 1M
R2,11,12,17 .... 10k
R3 .... 200k
R4,R14 .... 47k
R5 .... 2k2
R6 .... 8k2
R7 680
R8 .... 1k5
R9,10,15,16,18,19 .... 100k
R13 .... 4k7
R20 100
All 0.5W 1% metal film.

Capacitors

C1 .... 100p polystyrene
C2,7,8,10,11,14,15 ... 100n polyester
C3 .... 1n polystyrene
C4,9,12 .... 10u elect. 50V
C5 .... 470p polystyrene
C6 .... 22n polyester
C13 .... 1u polyester
C16 .... 470u radial elect. 16V

Semiconductors

TR1 .... BC184L, 2N3904 npn
IC1. 4011B CMOS quad NAND gate
IC2 4016B CMOS quad analog switch
IC3 .... TL064 quad op amp

Miscellaneous

14-pin DIP sockets; Veropins; 8mm ferrite rod, 10cm length; 32 gauge enamelled copper wire; heatshrink sleeve (see text); PCB

nections between the two can normally be made using the cheapest three-core cable available; screening and similar precautions are unlikely to be necessary.

Circuit

In the detector circuit diagram, Fig. 3, the coil L1 is driven by a simple oscillator formed by two NAND gates IC1a and IC1b. The coils each have an inductance of about 2.5mH, so with C3, 1nF, the frequency is about 100kHz. This is low enough for simple processing but high enough for the characteristics of the ferrite. With L2 positioned as described, an output only appears when it moves away from the "null".

As the small movements to be detected produce small signals, TR1 provides voltage amplification of about ten. It collector output is buffered and inverted by IC3a and IC3b. The two antiphase signals from these go to an electronic two-way switch formed from IC2, a CMOS 4016B quad analog switch, and the remaining two gates of IC1. The switch output is similar to that of a full-wave rectifier, but is positive or negative depending upon the phase of the input relative to that of the driving oscillator.

A DC reference of half the supply voltage is required for the op-amp stages of the circuit, this is supplied by IC3c and appears superimposed on the switch output. Simple low-pass filtering, R17, R18 and C13, C14, removes the high frequency component of the signal, leaving a DC output that is nominally half the supply but swings positive or negative with coil movement. This is buffered by IC3d for transmission to the control unit.

Stability

Much care has been taken in the design of this circuit to ensure good long-term and thermal stability. Gains have been kept to conservative values and impedance matching resistors are used in all op-amp input stages. Experience with the prototype over the last three to four months suggests that these measures are more than adequate.

Supply

The "Control" part of the circuit, Fig. 4, provides a regulated supply for the detector and processes its output. A 12-0-12 volt 100mA transformer and bridge rectifier produces two supplies, positive and negative. These are regulated with three- terminal 100mA regulators IC1 and IC2 to give +12 volts and -5 volts relative to the "common rail". This rail is also the negative supply and common for the detector, and is intended to be grounded.

The purpose of the negative supply is to enable the output to swing below as well as above the grounded common, since many chart recorders require such a signal. The signal processing part of the circuit begins with low-pass filter R9 and C11, which removes any noise induced in the connecting lead between the units, although the low output impedance of the detector unit should minimize such interference. The signal is then amplified by IC3b, a non-inverting amplifier with a voltage gain set at about two.

The other half of IC3 (IC3a) provides a reference voltage controlled by VR1 and VR2, "coarse" and "fine" zero adjusters. It will be recalled that the input is a voltage that varies about a nominal value of six volts; the effect of R7 is to shift the output downwards by six volts to swing about the "common" rail.

PARTS LIST

CONTROL UNIT

Resistors

R1 .... 18k
R2 .... 180k
R3,4 .... 10k
R5 .... 4k7
R6,9 .... 100k
R7,8 .... 220k
R10 100
All 0.5W 1% metal film

Potentiometers

VR1 .... 10k lin. carbon
VR2 .... 10k lin. carbon

Capacitors

C1,C5 .... 470u elect. 35V
C2,3,6,7,10,11 .... 100n polyester
C4,8 .... 100u radial elect. 25V
C9 .... 1u polyester
C12 .... 47n polyester

Semiconductors

D1-4 .... bridge rectifier, 50V 1.5A
IC1 .....78L012 12 volt pos. regulator
IC2 .... 79L05 5 volt neg. regulator
IC3 CA3240E, dual MOSFET op amp

Miscellaneous

SK1 .... 4mm socket red
SK2 .... 4mm socket black
SK3,SK4 .... phono sockets
T1 .....transformer 12-0-12V 100mA
S1 .... SPST toggle switch

PCB; 8-pin DIP socket; case 150X80X50mm; control knobs

Construction

Construction can start with the Control unit, since the 12V supply will be needed for testing the detector. After ensuring that the board fits the slots of the moulded case, the transformer should be mounted on it. The holes for this are not provided as their spacing will vary with different makes of transformer. Its position can be seen from the layout Fig. 5, and the mounting screws should connect its metalwork to the large grounded area of copper on the PCB.

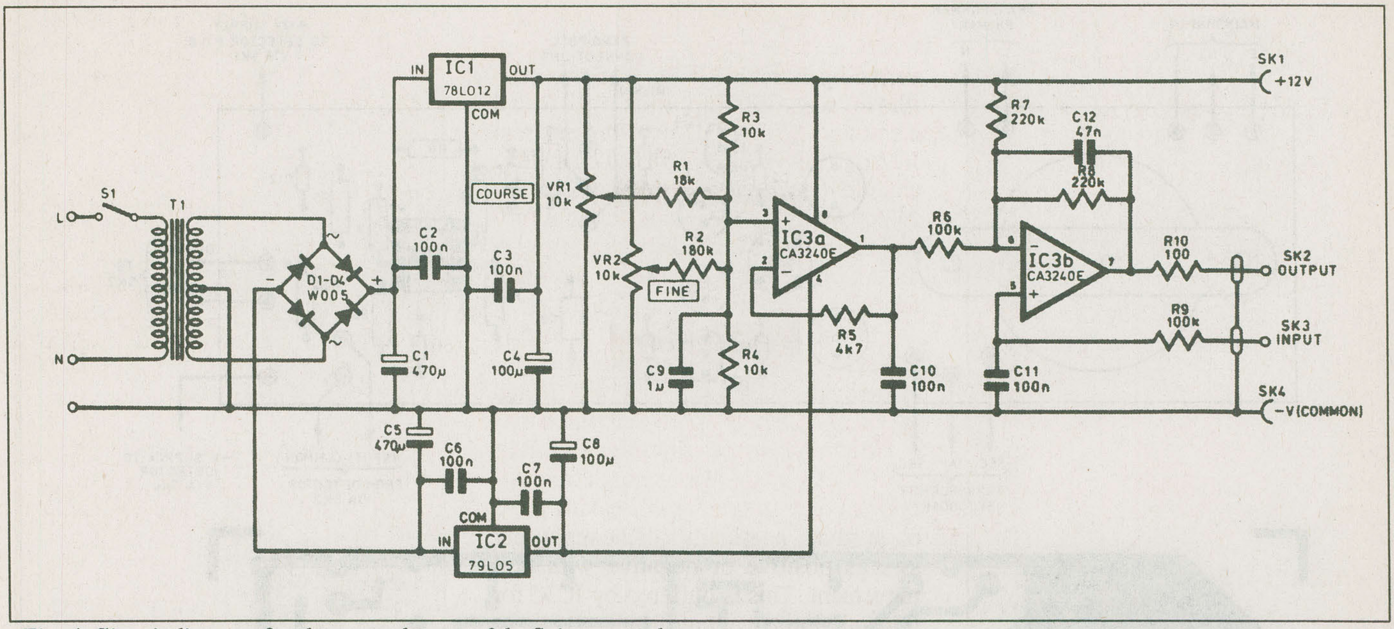


Fig. 4. Circuit diagram for the control stage of the Seismograph.

The bridge rectifier and 470uF capacitors C1 and C5 should be fitted, taking care with polarity, and the unit powered up. Since this implies connection to live mains, the usual precautions should be taken to avoid inadvertent personal contact.

A check should reveal about 17 volts across each capacitor. If this seems OK, C2, C3, C4 and C6, C7, C8 should be added (with the power disconnected of course), with the regulators IC1 and IC2. Check the polarity of the two 100uF capacitors. If the unit is energized again, the 12 volt positive supply should now appear across C4 and the 5 volt negative across C8.

With the power supplies operating correctly, the remaining components can be fitted. A socket is recommended for IC3; these cost only pennies and make trouble-shooting far simpler.

Resistors R1 and R2 are not mounted on the PCB R6 sets the circuit gain. If it is desired to experiment with this, R6 may be mounted on Veropins for easy access, or even replaced by a variable component. The stage gain is given by R8/R6. With the value given, the sensitivity of the prototype was about 50mV per thousandth of an inch of movement when the coils were 5mm apart, half this at 10mm apart.

Testing

The board is now ready for final testing. Two 10k resistors should be connected from the supply rails to the input as shown in Fig. 6, and one pot and the 18k resistor to the zero-setting connections. IC3 should be inserted. If the unit is energized and the output monitored, the pot should provide output adjustment of plus and minus 2.5 to 3.0 volts (2.8 on prototypes).

A "wet" finger across one of the 10k resistors should produce movement in the appropriate direction and the 180k resistor across either should cause a shift of about 0.7 volt. A quick retest of the supply volts, +12V and -5V, and a check that nothing is overheating completes the job. The transformer and IC2 run slightly warm; this is normal.

Coils

The coils are needed to test the detector PCB, so these can be wound next. Each consists of 250 turns of 32 gauge enamelled copper wire, layer-wound over 4cm of a 5cm length of ferrite rod. The ferrite is cut to length by notching around it with a fine- toothed file and snapping it. A layer of insulation tape keeps the wire from touching the ferrite.

Once wound, the wire must be secured to prevent movement, which would affect stability in this project. There are various ways to do this; for the prototype heatshrink sleeving over each coil provided both security and protection to the windings, but a dip in potting resin might be even better. None of the coil dimensions is critical in any way, as only one coil is resonant and the frequency only has to be approximately correct.

Detector Board

Construction of the detector board begins with the fitting of all components as shown in Fig.7, save the three ICs. Sockets should be used for these; they should not be inserted

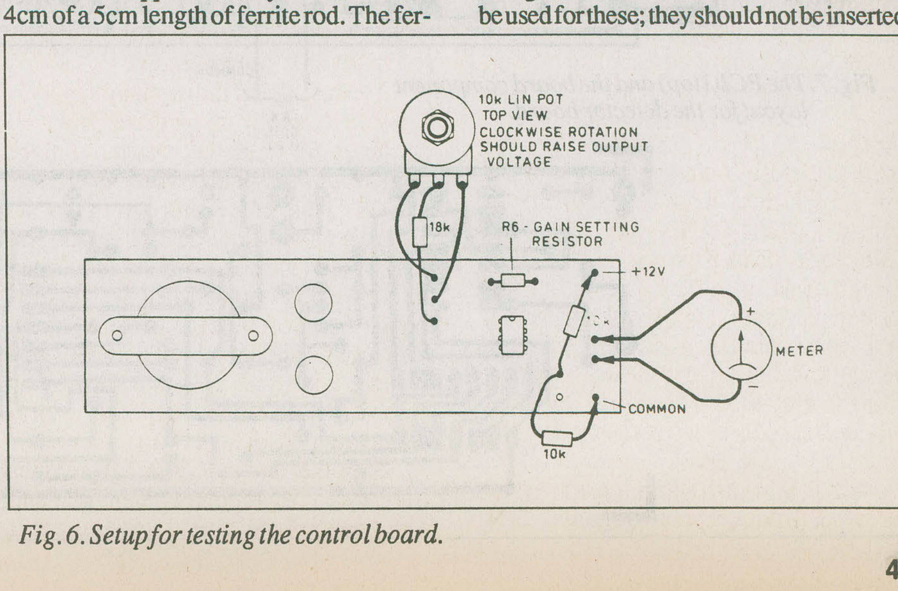


Fig. 6. Setup for testing the control board.

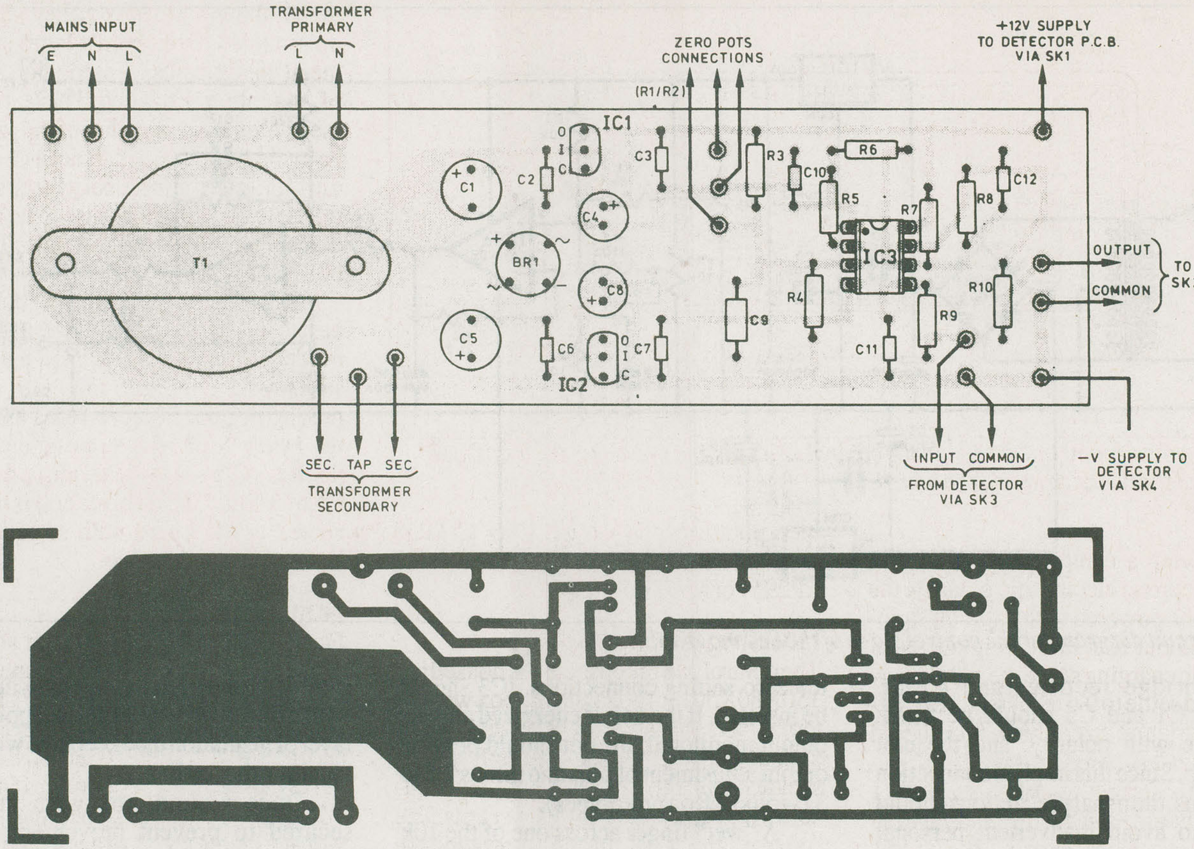


Fig. 5. Control unit PCB and component layout.

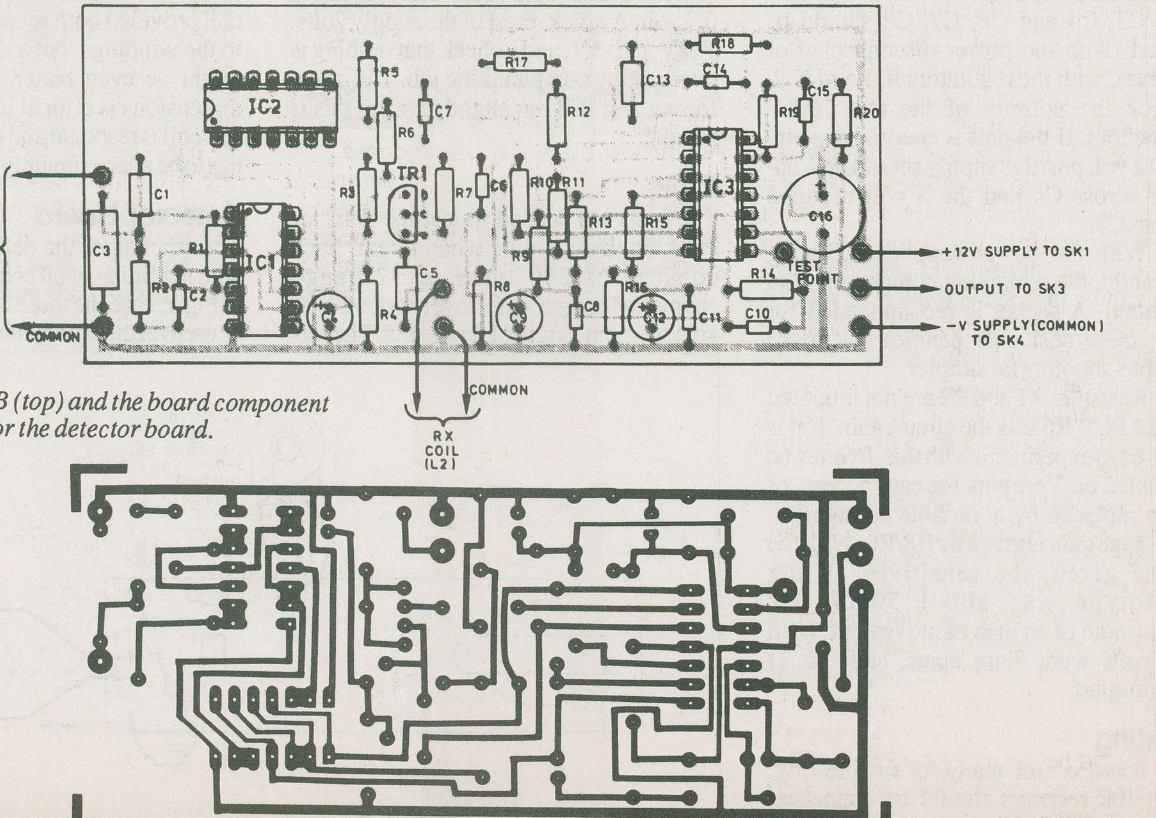


Fig. 7. The PCB (top) and the board component layout for the detector board.

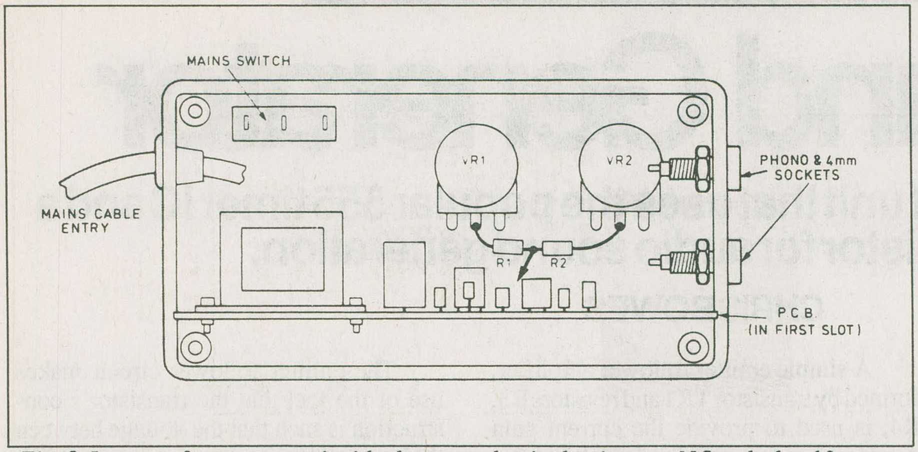


Fig. 9. Layout of components inside the control unit plastic case. NOte the lead from junction of the two resistors to the board.

yet.

following a careful physical check, including correct electrolytic polarity, the board can be powered with a 12 volt supply, still without ICs. Following the usual electrolytic charging surge the supply current should settle to 0.6 to 0.7mA. Any significant variation from this value should be investigated before proceeding. Assuming it is correct, the voltage at TR1 collector should be about 6 volts above the negative (common) supply. If so, IC1 should be inserted and the TX coil connected. This will push the supply current to around 1mA and the four output pins of IC1, pins 3, 4, 10 and 11, should appear to be at about 6 volts DC although in reality they will be switching from rail to rail at the operating frequency.

Next insert IC3. This will raise the supply current to about 1.8mA. The first three outputs, pins 1, 7 and 8, and the "test point" (driven from pin 8), should all be at 6 volts, set by divider R15 and R16. If so, IC2 can be inserted and the receiver coil L2 connected. The output should be monitored and the coils placed at right angles to each other, 5mm to 10mm apart. Careful adjustment of their relative positioning should locate a 6 volt output point, the "null".

Alternatively, the meter can be connected between the test point and output, where the null will give an output of zero volts with movement to either polarity. If the coils are around 5mm apart, a sideways movement of 2mm to 3mm should cause an output change of one volt, with polarity depending upon direction. The final current drain will vary slightly but should be about 1.8 to 1.9mA. This low supply current will allow long-term use from batteries if necessary, especially if the p.s.u. board is replaced with a circuit incorporating one of the new C-MOS micropower regulators such as the RS LP2951 or MAX666CPA.

Housing and Mounting

The control and output board is housed in a 150X80X50 mm ABS plastic box with internal slots for the PCB Input and output connections are made through phono sockets, while the 12 volt supply is available from red and black 4mm sockets. The "coarse" and "fine" zero adjusters and the mains switch are situated on top of the box. Wiring between these components is shown in Fig. 8. A 100mA cartridge fuse could be incorporated into the case if preferred.

The detector board is not housed, as in most cases it will be incorporated into the equipment with which it is to be used.

Setting up and use of the detector is straightforward as it is very tolerant of misalignment, much of which can be compensated for with the "zero" adjustment. The coils are not too sensitive to nearby metal, though obviously they should not be mounted hard against large structural metal components. In particular, any form of mounting that involves a complete metal loop around wither of the coils must be avoided as this would act as a "shorted turn" drawing much energy from the system. If twists of wire are used, they must be of insulated wires. Nylon cable ties would be fine, or perhaps glue.

For the Seismograph installation, it is best to install the transmitter coil L1 on the moving beam, with a twisted pair of thin wires connecting it to the PCB, with the flexing portion of these wires as close to the beam's fulcrum as possible. At this point it will have the least influence on the beam action. The receiver coil is best connected to the board with screened lead, kept as short as possible.

Adjustment

For correct adjustment a meter should be used to set up the detector, connected between output and the "test point". It should have a range of plus and minus one volt, and the coils should be adjusted for an output as close to zero as possible. If desired a 100-0-100uA meter can be fitted together with a suitable series resistor, say 10k, for continuous local indication.

In areas of high interference it may prove necessary to screen the signal lead between the two units. Two-core screened wire could be used, with the negative supply (common) connected to the screen and the 12 volt positive supply and signal to the cores. In most installations this shouldn't prove necessary though, simple 3-core cable or telephone wire, etc. should be adequate even over long distances.

Next Month: Mechanical assembly, setting-up and seismic recording. ■

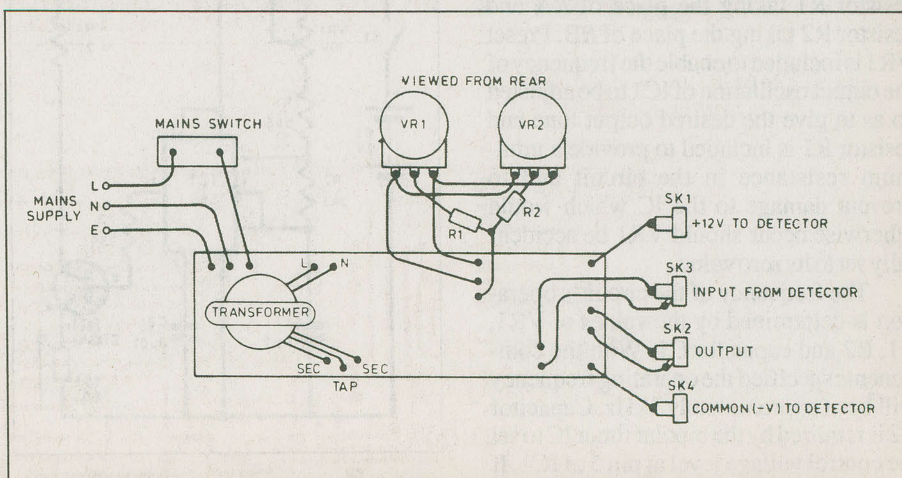


Fig. 8. Interwiring from the board to case mounted components.

PROJECT

IC Sound Generator

A very simple, low cost unit that uses the popular 555 timer IC and a single transistor for audio sound generation.

CHRIS BOWES

This month we introduce a simple IC Sound Generator circuit, which can be used either on its own or incorporated with other circuits in this series to provide an audible addition to a control or alarm circuit. Like all of the circuits in this series it can be operated from a single nine volt battery and may be mounted inside a case if this is desired.

The generator circuit uses a 555 timer in the standard astable mode. The basic circuit for this is shown in Fig. 1a. In this arrangement the IC produces an output at pin 3 (the IC's output connection) which repeatedly switches on and off in a timed sequence as shown in Fig. 1b. The duration of the on and off periods is governed by the values of *R*zA, *R*B and in *C* in the manner shown in Fig. 1b.

The output current from the 555 timer is not sufficiently high to enable the circuit to directly drive a loudspeaker so a single transistor is used as an emitter follower to provide the necessary current handling capacity.

Circuit Description

The full circuit diagram for the IC Sound Generator is shown in Fig. 2. Basically the circuit consists of the 555 timer astable circuit shown in Fig. 1, with preset VR1 and resistor R1 taking the place of *R*A and resistor R2 taking the place of *R*B. Preset VR1 is included to enable the frequency of the output oscillation of IC1 to be adjusted so as to give the desired output tone and resistor R1 is included to provide a minimum resistance in the circuit and to prevent damage to the IC which would otherwise occur should VR1 be accidentally set to its zero value.

The frequency of the circuit's operation is determined by the values of VR1, R1, R2 and capacitor C1. With the components specified the operating frequency will be at approximately 1kHz. Capacitor C2 is required by the bipolar timer IC to set the control voltage level at pin 5 of IC1. If you use the CMOS version of the 555 timer then C2 may be omitted.

A simple emitter follower amplifier, formed by transistor TR1 and resistors R3, R4, is used to provide the current gain needed to drive the loudspeaker LS1. When a current flows through the base-emitter circuit of the transistor, this allows a much higher current to flow through the collector-emitter circuit.

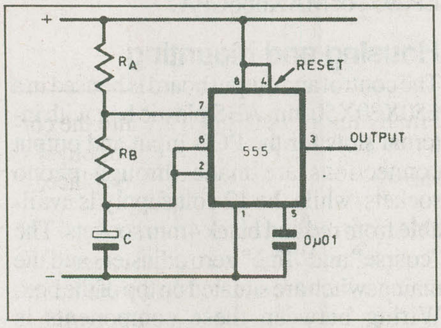


Fig. 1.a. Using the 555 timer in the stable mode.

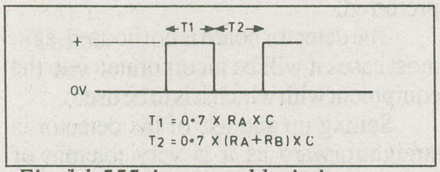


Fig. 1.b 555 timer astable timing diagram.

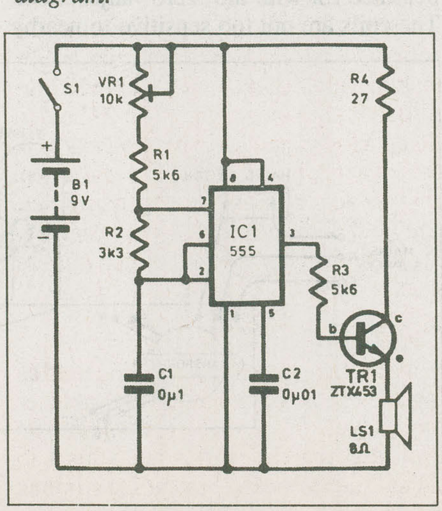


Fig. 2. Complete circuit diagram for the IC Sound Generator.

The emitter follower circuit makes use of the fact that the transistor's construction is such that the voltage between the base and emitter is maintained at 0.7V. When the voltage at the output (pin 3) of IC1 is at the 0V level, then no current flows through TR1. When the voltage at pin 3 rises to the battery voltage, then a current flows through the base-emitter circuit.

In order to maintain the base-emitter voltage at 0.7V the voltage across the loudspeaker consequently rises to approximately 0.7V less than the battery voltage. As the output from IC1 is constantly being switched on and off this causes the voltage across the loudspeaker to be switched on and off at the same frequency.

Resistor R33 is included in the base circuit of TR1 to ensure that the current flowing through the base-emitter of the transistor is kept to a safe level. Similarly, resistor R4 is included in the collector of TR1 to restrict the maximum current flowing through the loudspeaker to a level which will prevent damage occurring.

Construction

The first task when commencing the construction of the IC Sound Generator is to cut a piece of stripboard 13 strips deep and 20 holes wide. If you are going to mount the project into a box by using PCB stand-offs, you will need to allow an extra six holes width (three each side) on the board for case mounting holes using a 4mm drill, make these mounting holes at the four corners of the board before starting to construct the circuit.

The component layout and details of breaks required on the underside copper tracks is shown in Fig. 3. It is important that these track breaks are made completely so that not even the merest sliver of copper remains to bridge across the track break.

Once the board has been prepared you can start the electronic construction. To help with this the strips and holes have been numbered and lettered, see Fig. 3.

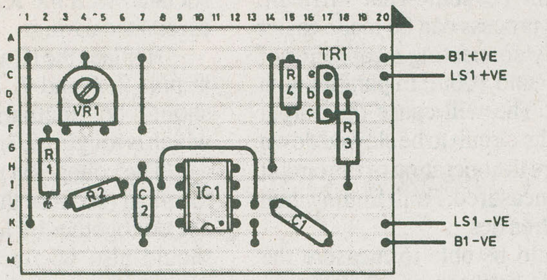
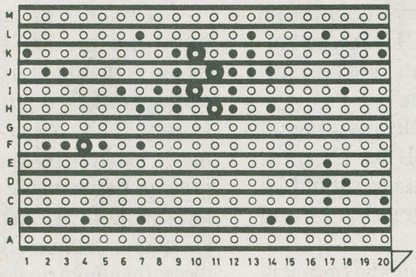


Fig. 3. Stripboard component layout and details of breaks in the underside.



Although it does not make any difference to the operation of the circuit which order you insert the components into the stripboard, you will find it easier to construct the circuit if the components are inserted in ascending order of size. Commence by inserting and soldering the five link wires into place, as shown in Fig. 3. The wire links are made with insulated single-core wire and after soldering in place cut off any excess wire protruding on the underside of the board with your cutters.

The next task is to put the resistors in their correct places by first bending the wires of the resistor at right angles to the body of the component so that they will fit through the holes, as shown in Fig. 3. Counting across and down the board, using the numbers and letters as a guide, put all of the remaining resistors into their correct positions and solder them into place. Also fit and solder preset VR1 into place.

The next item to be inserted into position is the IC holder. Although it is possible to solder the IC directly into place, using a socket will both make the construction simpler and make for easier replacement if a fault should occur. It is important that you take care to make sure that the notch on the IC holder is facing towards the bottom of the stripboard as this will help you when inserting the 555 timer into place.

Next come the capacitors, which are both non-polarized types so it does not matter which way round they are inserted. Finally insert transistor TR1 into the correct holes, making sure that it is oriented as shown in Fig. 3, and soldered into place.

Interwiring

The connecting wires to the battery can now be soldered into place on the board. The black wire from the battery connector goes to the point on the stripboard shown as B1-V and the red wire of the battery connector goes to one tag of the on/off switch S1. Another red wire is then connected between the other switch terminal and the B1+V connection on the stripboard.

Two wires should also be soldered to the loudspeaker and connected to the LS1+ and LS1- connection points on the stripboard.

The final step, prior to connecting the battery, is to insert IC1 into its holder making sure that the notch on the IC corresponds with the notch on the IC holder. Some versions of the 555 timer do not have a notch in one end but have a slight, circular dent near pin one. In this case the end with the indentation goes nearest to the edge of the IC holder which has the notch.

Case

Although the project can be easily used as it stands or be incorporated into another project, you may wish to mount it into its own case. The easiest way to do this is to use self-adhesive PCB mounting strips as shown in the photographs. Alternatively, you may use stand-offs in the position of the mounting holes previously drilled in the stripboard before making the circuit up. The requisite holes should be carefully marked on the body of the case and the appropriate stand-offs mounted in suitable positions to support the stripboard. Similarly suitable mounting holes must be drilled to accommodate the switch S1 and loudspeaker LS1.

In the version of this project shown in the photographs the loudspeaker is not provided with mounting holes so it was necessary to hold the loudspeaker against the case lid by means of a strip of material which spans the width of the loudspeaker and is held in place with two bolts which are accommodated in suitable holes drilled in the case. It will also be necessary to drill a matrix of holes in the lid to allow the sound from the loudspeaker to be transmitted.

In order to provide remote switching the case can be fitted with a small switched jack socket, which is mounted in the side of the case and wired in series with the battery and switch S1. If desired the switched socket can be wired in such a way that when the jack plug is removed the socket is shorted out — thus allowing the circuit to be controlled solely by S1 until the jack plug is inserted, when the circuit can then be controlled from the end of the cable

PARTS LIST

Resistors

R1	5k6
R2	3k3
R3	1k
R4	27

All 0.25W 5% carbon.

Potentiometer

VR1	250k min. preset, horiz.

Capacitors

C1	0u1 Mylar 16V
C2	0u01 Mylar 16V

Semiconductors

TR1	ZTX453, 2N2219 NPN
IC1	555 timer

Miscellaneous

LS1	8 ohm loudspeaker
S1	optional switch
SK1	3.5mm switched socket (opt.)
B1	9V battery

Stripboard, 0.1" matrix 13 strips X 20 holes (see text); plastic case to suit (optional); 8-pin IC socket; battery connector; connecting wire; solder, etc.

connected to the jack plug.

When preparing the case all of the holes required should be drilled before installing the circuitry. Similarly if the case is to be painted or lettered this should be completed before the circuitry is installed.

Testing

Before connecting the battery and testing the circuit you should carefully examine the stripboard to make sure that all of the components are inserted into their correct places, are the correct way round and that there are no blobs of solder shorting out the tracks.

If the circuit does not operate correctly it will be necessary to check for faults. In this project the only components which will cause problems if they are connected the wrong way round are IC1 and TR1.

If no mechanical problems are found then it will be necessary to check the circuitry to see whether there is a faulty component or not. You will probably find that you will need to use a test meter to perform this stage of the process.

Because of the high frequency of operation of the circuit fault finding with a test meter can be somewhat difficult. However, the process can be made easier by temporarily connecting a capacitor of between 22uF and 100uF in parallel with capacitor C1. The will cause the output frequency of the circuit to be slowed down to a level where the operation of the circuit can be easily measured. Fault finding then becomes much easier.

You should be able to measure the battery voltage between any 0 volt connection and both pins 8 and 4 of IC1 as well as between the Battery+ connection to the board and pin 1 of IC1. If these voltages are not present this will indicate faulty wiring up of the stripboard.

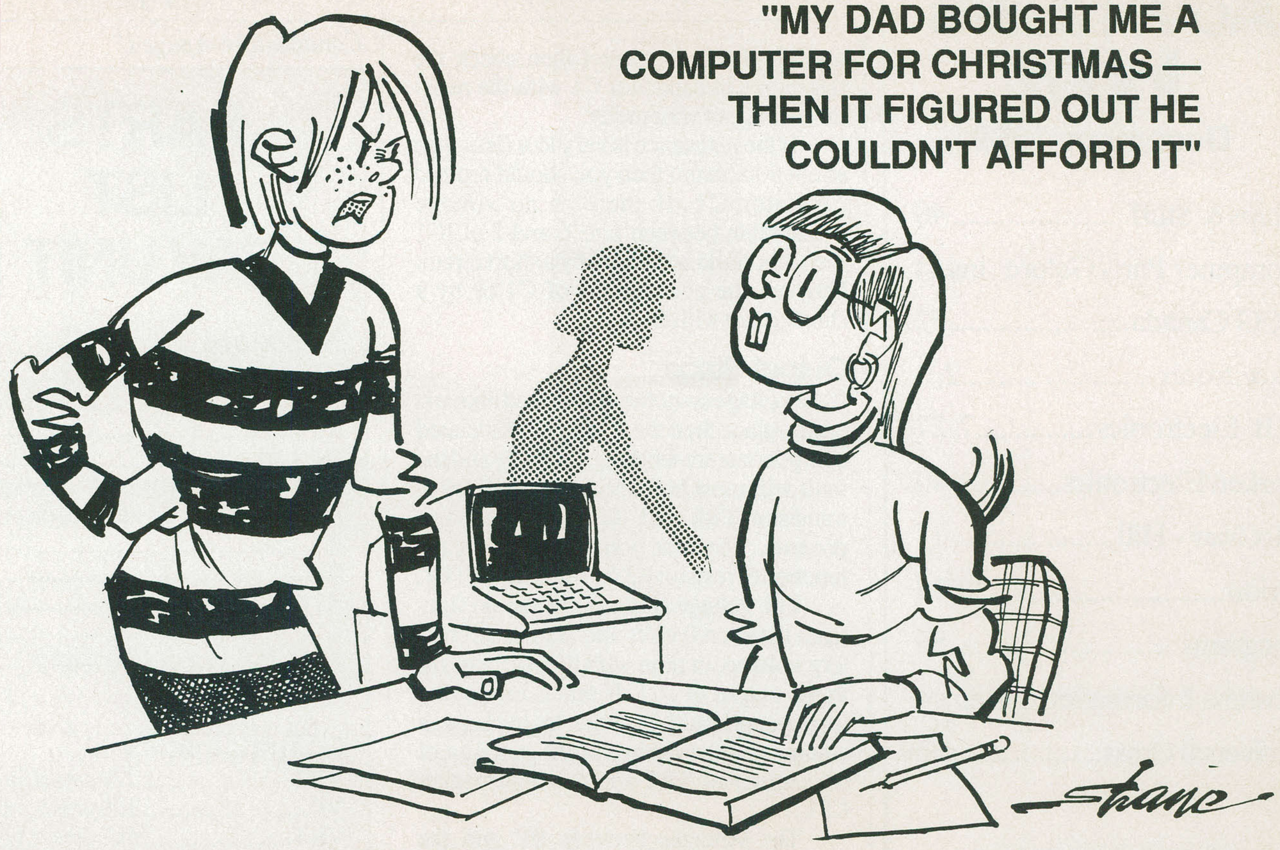
The next step is to check the voltage at the output (pin 3) of IC1. If the circuit is working correctly this voltage should be regularly switching between 0 volts and the battery voltage.

If this does not occur and the output is locked permanently at a fixed voltage then you should remove the IC from its socket and check the voltage at the pin 3 connection again. If the voltage persists with IC1 removed then the fault does not lie with IC1 but most possibly with the wiring associated with the IC and the output or its associated wiring.

Replace the IC and check the voltages at pins 2, 6 and 7. The voltage at pin 7 should be fluctuating around a value which is roughly 2/3rds of the battery voltage. The voltages at pins 2 and 6 should be identical (because these two pins are connected together by a wire link) and these should also be fluctuating in a similar manner, but at a voltage slightly less than that found at pin 7.

If neither or only one of these voltages are present then the most likely cause is that the circuit from the positive voltage rail, through preset VR1, resistors R1 and R2 is not correctly made. This is best checked by measuring the voltage present between 0V and each junction in the component chain through VR1, R1, R2 and capacitor C1 and investigating at the point where no voltage is measured.

If a voltage is present between 0V and pin 7 but no voltage, or only a very small voltage, is measured between the 0V rail and pins 2 or 6 of IC1 then you should check that the resistance between pins 7 and 6 of IC1 is roughly equal that of resis-



"MY DAD BOUGHT ME A COMPUTER FOR CHRISTMAS — THEN IT FIGURED OUT HE COULDN'T AFFORD IT"

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Sound Generator

tor R2. If this is correct then check the resistance of capacitor C1 with the resistance range of your meter.

If the resistance is very low (less than about 500 ohms) then you should replace capacitor C1. If there is no voltage measurable between pins 6 and 2 of IC1 then this could be caused by a short circuit between the connections of C1 or by a short circuit within C1.

Output Stage

If the voltage switching described above is taking place then the IC and its associated components are working correctly and the fault will most probably lie in the area of transistor TR1 and its associated components. The first point to check is the junction of resistor R3 and the base of TR1.

The voltage at this point should fluctuate between 0 volts and almost full battery voltage, in time with the fluctuations in the output of IC1. If this is happening then you should be able to measure a similar voltage change at the junction of the emitter of TR1 and the loudspeaker LS1.

The voltages between 0V and the emitter and collector of TR1 should both be measured. The voltage at the emitter should rise and fall, following the fluctuations of the output from IC1. If the voltage at the emitter does not rise and fall but stays at 0V then the connections to the loudspeaker should be checked out.

If the voltage remains locked at a level approaching the battery voltage, then the transistor should be checked for correct function by removing it from the circuit and measuring the resistance between the base and emitter and the base and collector. It is important to measure these resistances with *both* polarities of the meter current.

Because of the construction of the transistor a high resistance should be measurable between the base and te other connections, with the base connected to one of the meter leads, and a low resistance should be measurable between the base and the emitter or collector, with the base of the transistor connected to the other lead of the meter. If the resistances measured do not match the expected results then the transistor should be substituted for a new one.

Setting Up

Once construction and testing are complete the circuit can be very easily set up by installing the battery, switching the circuit on and adjusting preset VR1 until a sound at the desired pitch is heard.

Power Supplies

Continued from page 15

PARTS LIST 30V UNIT

Resistors

R1 .... 47k
R2 .... 1.5k 0.5W
R3 100
R4,9,10 470
R5 .... 10 2.5W wirewound
R6 .... 300k 1% (see text)
R7 220
R8 560
R11 .... 2k2
R12 10
All 0..25W carbon film, except where stated.

Potentiometers

VR1 .... 22k preset, horiz.
VR2 .... 100 preset, horiz.
VR4 .... 4k7 preset, horiz.
VR3 .... 10k carbon, lin.

Capacitors

C1 .... 2200u axial elec. 63V
C2 .... 10n metal film
C3 .... 10u tantalum 35V.
C4 .... 100n metal film
C5 .... 220u axial elec. 25V
C6 .... 22u axial elec. 25V

Semiconductors

REC1 .... 2A bridge rectifier
REC2 .... 1.5A bridge rectifier
D1 .... 10V 400mW Zener
D2,3 .... 1N4148 signal diode
D4 .... 5.1V 400mW Zener
D5 .... 1N4002 1A 100V diode
TR1 .... 2N3055 NPN power
TR2 BFY51, 2N2297, 2N2219 NPN
TR3,4 .... BC182, 2N3904 NPN
TR5,6 .... BC107, 2N3904 NPN

Miscellaneous

S1 .... 2-pole toggle (or slide)
S2 .... centre-off miniature toggle
T1 transformers, 32V and 15V secs.
ME1 .... 50uA moving coil meter

Case, 16 ga. aluminum heatsink; corrugated TO heatsink; terminals, 4mm type 1 black, 1 red; 500mA fuse; connecting wire, solder, etc.